REPORT 2

THE NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY

FOUNDED IN 1921 FOR THE APPLICATION OF PSYCHOLOGY AND PHYSIOLOGY TO INDUSTRY AND COMMERCE

An Investigation of Certain Processes and Conditions on Farms

By W. R. DUNLOP

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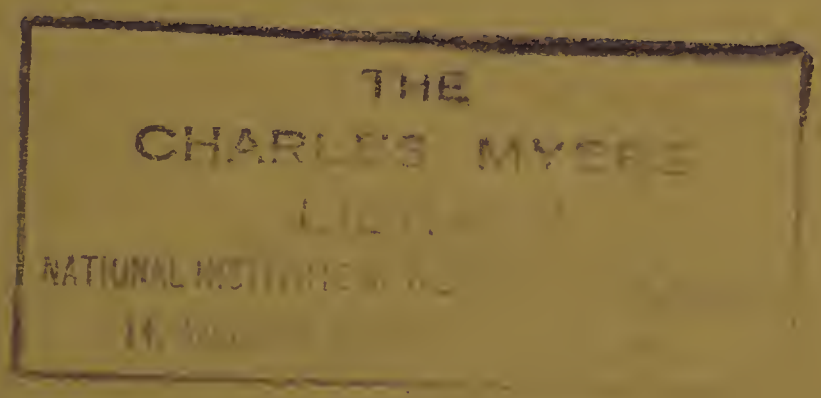

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By W. R. DUNLOP

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FOREWORD

This Report describes the first applications of the methods of Industrial Psychology to Agriculture and Horticulture in this country. The investigation was carried out under the supervision of the National Institute of Industrial Psychology on the College and neighbouring farms of the South Eastern Agricultural College (University of London) at Wye, Kent. To the Governors and Principal of the College, Mr. R. M. Wilson, B.Sc.(Agric.), sincere thanks are due for the facilities and hospitality which he so generously provided for the purpose. After reading Mr. Dunlop's conclusions in manuscript, he wrote to him, " I earnestly trust that your report will result in further research being done in this all-important field of work." The Report was also shown to Sir Daniel Hall, K.C.B., F.R.S., Chief Scientific Adviser to the Ministry of Agriculture, to Dr. T. B. Wood, C.B.E., F.R.S., Drapers Professor of Agriculture, University of Cambridge, and to Mr. C. S. Orwin, M.A., Director of the Agricultural Economics Research Institute, University of Oxford, whose help and criticisms have been of great value. Sir Daniel Hall expresses the view that " it should certainly be published as an example of a field that needs to be explored, work in which might have a great effect on the achievements of agriculture," and Professor Wood and Mr. Orwin are of the same opinion.

It is for these reasons that the Institute has decided to publish the Report as it now stands. Mr. Dunlop was Scientific Adviser, during the years 1912–16, to the Imperial Commissioner of Agriculture for the West Indies, but he would not claim to be an expert on the practice of British Agriculture. His investigations were necessarily limited both in time and place. As Mr. Orwin justly observes in a letter to me—" far more work will have to be done before many of his conclusions can be justified." If certain statements are found to be somewhat dogmatic, this was hardly avoidable in the circumstances.

The appearance of the Report will therefore be justified if it leads to further investigations upon the subject and if it indicates the vast improvements in efficiency and contentment, which may be expected from a systematic study of the worker's movements, unproductive time, arrangement of material, methods of payment, general lay-out, suitability of tools, and the selection of the worker according to his special abilities for the work which he has to undertake.[1]

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[1] Useful reference in this connection may be made to an article " The Science of Farm Labour; Scientific Management and German Agriculture," which appeared in the *International Labour Review* (March 1927, vol. xv, No. 3), as this Report was being sent to press. Increases in output ranging from 10 to 35 per cent., and savings in time varying from 25 to 50 per cent., resulting from such studies as those above mentioned, will be found there recorded.

The expenses of publication and part of the cost of the investigation have been met from a research grant generously given to the National Institute by the Laura Spelman Rockefeller Memorial of New York.

The investigation was supervised on behalf of the Institute by Mr. A. Rex Knight, M.A., the value of whose co-operation both Mr. Dunlop and I wish here to acknowledge.

CHARLES S. MYERS (*Director*)

National Institute of Industrial Psychology,
329 High Holborn, London, W.C. 1.
April 1927

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ECONOMIC SIGNIFICANCE OF THE INVESTIGATION

DURING the last few years there has been a great deal of discussion and controversy concerning British agriculture which has given rise to what has become known as the "Agricultural Argument," or to what might be more appropriately termed the "Agricultural Arguments." Broadly speaking, the essential question therein involved is whether the agricultural land of this country is being utilised to the fullest possible extent, that is to say, whether farmers are getting from the land its maximum economic yield. The question has been made very complicated and has given rise to much confusion of thought, owing to the introduction of arguments having ends which are social and political rather than economic. Instances of this are afforded by the "back to the land" movement, nationalisation of the land, and the suggested increase in the production of home-grown food for purposes of national security. In the last resort it is the country's need, combined with what is practicable or economic, that matters. Everyone agrees that it is desirable for the nation to increase its home-grown food supply *on an economic basis*. The real question is to what extent this is possible. It is clearly a matter of selling prices and costs in relation to the natural resources available.

During the last few years selling prices, or rather their fluctuations, have been such as to lead to reduced production in this country both in the aggregate and per acre, as exemplified by the conversion of arable land into grass and the reduction in the number of small holdings. There has been a tendency to cut down the expenditure of capital and labour. In other words, land is becoming more and more the principal factor in production. This is a normal though somewhat crude and wasteful economic reaction to unfavourable selling-price conditions. But there is another line of reaction possible ; and that is closer scrutiny of the efficiency with which capital and labour are utilised.

Several writers of authority have vigorously defended the suggestion that England is under-farmed, or, what comes to the same thing, that farm management is not as efficient as it might be and that the maximum economic yield is not being obtained. Professor Macgregor, a member of the Agricultural Tribunal of 1923, says[1] : "In two ways the statement that we are seriously under-farmed can be considered—the direct observation of experts and the use of returns of yields." In pursuing the former way he quotes Sir Daniel Hall (*A Pilgrimage of British Farming*) and Sir Thomas Middleton, both of whom are credited with a firm belief in the efficiency of British farm management. In his second method of considering the matter, Professor Macgregor employs composite productivity indices and shows that the yield per acre in England is less than that in Belgium but equal to that in Germany, Denmark and other European countries. It is difficult to see that this provides any indication of relative efficiency, for it ignores relative unit costs of production. The efficiency

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[1] *Economic Journal*, Sept. 1925, p. 391.

of British farm management is also at least implicitly upheld by Mr. Dampier Whetham, who attributes most of the farmer's economic difficulties to prices, more particularly to economic lag between costs and revenue. "The root of all evil is prices. An extra yield can only be wrung out of the land at an expense which means a loss on the transaction. British farmers are quite able to increase their output when times (*i.e.* prices) warrant the necessary outlay." [1]

The results of research into agricultural costings in Great Britain seem at present to throw but little light upon the question of efficiency. It is not enough to be told that in mixed farming 2·5 men are employed per 100 acres, while in grazing 1·3 men are employed.[2] What is needed is investigation into the question whether the 2·5 men are necessary. Similarly as regards unit costs, knowledge can be secured only by the scientific study of work itself, including management, on the farm.

The economic significance of the present Report lies in the fact that it is a contribution in this direction. Its general findings, as regards efficiency, are not in agreement with the opinions expressed by many agricultural economists and experts; and this may be partly attributed to the fact that those opinions are not based on actual measurement and analysis of work in the field.

From the economic point of view, emphasis throughout this Report is laid on individual differences and on waste of time. The general policy advocated is the reduction of real costs without reduction in wages. This raises the question of possible reactions on employment and production. If, for example, by scientific management, the time taken to milk a herd of cows can be reduced by 25 per cent., will the farmers tend (*a*) to reduce the number of workers employed, (*b*) to allow the workers shorter hours, (*c*) to utilise the saving in doing other work on the farm, or (*d*) to increase the number of cows? A great deal will depend on circumstances, especially on the characteristics of the individual farmer. Certainly the worker should in no wise be allowed to suffer, but indeed should share in the benefits derived from greater efficiency. Concerning production, it would seem evident that in a country like Great Britain, where conditions of demand are favourable, the ultimate results of improved efficiency must be to increase production; for if the farmer merely rests content with increased profits and the same production, it will tend to draw other producers into his line of business and incidentally provide further means of employment for labour.

In the above brief discussion of the economic significance of the work described in this Report, it is not intended to imply that the actual results so far obtained are in themselves capable of leading to any great increase in production. Nor is it claimed that studies made in such a small region as that

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[1] *Economic Journal*, March 1926, p. 13.

[2] *The Work of the Agricultural Economics Research Institute*, Oxford, 1925.

investigated necessarily reflect the general standard of farm management in the British Isles. The argument is that the results obtained strongly indicate that farm management in this country is not as efficient as many seem to believe. Our home-grown food supply, even at present prices, is capable of being considerably increased by the general adoption by both farmers and workers of improved management and by investigations along lines similar to those described in this Report. And if, as many people seem to think, Great Britain is losing ground as an industrial country owing to foreign competition, the point of view and the work described in this Report are likely to prove of considerable importance in assisting the new adjustments that will become necessary in regard to our population and its employment.

INTRODUCTION

This Report embodies the results of the first systematic attempt in this country to apply the point of view and methods of Industrial Psychology to agriculture. The investigation materialised as a result of the favourable attitude of the National Institute of Industrial Psychology on the one hand and of the Principal and Governing Body of the South Eastern Agricultural College (University of London) on the other towards the writer's request for facilities and co-operation. An arrangement was arrived at whereby the National Institute gave the writer the benefit of its general supervision and guidance, and the College gave facilities for investigation; both gave some financial assistance. The actual investigation was necessarily limited in both time and space. It extended over a period of three months (July, August, and September, 1926). The work was carried out on the College farms at Wye, on neighbouring farms, and on one or two more distant farms—all, however, within the county of Kent.

The object of the investigation was to demonstrate in a practical and scientific manner that Industrial Psychology can be usefully applied in agriculture as well as in the manufacturing industries, mining and commerce. In some degree this object has been achieved. It was scarcely to be expected, however, that industrial psychological investigation in agriculture would lead to the same spectacular results, to the same immediate reduction of waste of time and of fatigue, as it often does in the factory. In agriculture it has to be remembered that unit costs are to a very large extent determined by natural yield, while the organisation of the work itself is to a large extent regulated or governed by factors of nature beyond the immediate control of man. Moreover, although there are 1,500,000 persons in Great Britain directly dependent on agriculture, a single farm which employs more than a dozen regular hands is a rarity. Agriculture, also, is characterised by a geographical "spread-outness" which inevitably involves unproductive time; also by a slow rate of capital turnover, the rate being less than 1 compared with 5 or 6 in the case of some manufacturing industries and over 50 in the case of certain retail trades. For these among other reasons, it is evident that agricultural conditions are peculiar,[1] and that the benefit to be derived from improved management must not be considered merely from a factory standpoint; nor must it be thought of in terms of single farms or very short periods of time, but rather in terms of farming as a whole over a period of years. It is a question of national policy rather than of individual policy; and in the opinion of the writer the encouragement of research in agricultural psychology comes within the ever-increasing functions of the State.

But there are exceptions. In cases where agriculture merges into industry, as in the picking, grading and packing of large quantities of fruit, the

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[1] There are, however, many strikingly parallel features between agriculture and mining, as the writer has shown in another publication.

opportunities presented for getting quick and striking results of sufficient immediate value to the owner appear to justify him in paying for the services of a private investigator. It may perhaps be said that in horticulture generally there are also possibilities in this direction. But in " land industry " as a whole, the application of Industrial Psychology is a matter for encouragement and support either by the State or by large associations of agriculturists. This must not be taken to mean that the agricultural field is lacking in scope or practical possibilities. For the introduction of an improved outlook, of improved methods and conditions, there is considerable scope. But to be economic and thoroughly effective it must be on a national or regional basis.

PROBLEMS INVESTIGATED

In the study of agricultural work and conditions, the field from which problems may be selected is very wide. It will be evident that in the limited time available for the present investigation only two or three themes could be studied with any degree of thoroughness. Some little time was spent in considering what problems to investigate. It was eventually decided that the following would best serve the main purpose of the inquiry : I. The Picking and Packing of Fruit ; II. The Milking of Cows.

An account of the investigation of these two problems constitutes the bulk of this Report. The work is described in greater detail than is necessary or even desirable in a scientific paper, for the main reason that it is hoped that this Report may be studied by practical agriculturists and by students in agricultural colleges. To these, practical details are interesting and important.

It should be borne in mind, however, that the objects of this inquiry were not only to investigate the specific processes referred to above, but also to survey the agricultural field and to indicate its possibilities for psychological study generally, especially in regard to such important matters as farm " lay-out," the relations between farmers and workers, and vocational guidance and selection. Careful observations and inquiry were made and the conclusions arrived at are briefly described under : III. Matters for Future Inquiry.

In concluding this general introduction, a few remarks are necessary concerning the experimental aspect of the work. An essential feature of that part of the investigation which deals with methods of work is the practical trial of new methods and conditions, the measurement of results, and the comparison of these results with those yielded before the experiment. Since a considerable number of the practical suggestions made in this Report have not actually been subjected to trial, the reasons for this omission may be briefly explained. In the first place, in asking for facilities it was thought wise not to press, in the first instance, for permission for that interference with routine work which a strictly experimental trial necessarily involves. In the second place, many kinds of work, such as fruit picking and packing, are so seasonal and

fleeting in duration that there is practically no time to analyse, observe and make experiments in one and the same year—especially in a subject which has not previously been studied and where the development of standard methods is needed. It is hoped, however, that many of the suggestions not yet tested may be subjected to practical trial at some future date. Their adoption, without definite quantitative proof of the effect which they produce, is not sufficient.

Lastly, it must be pointed out that the study of agricultural work is rendered extremely difficult, in comparison with most factory work, through the existence of a highly variable environment and great variation in the material handled by the workers. This is emphasised in the course of the following pages, and it is hoped that in assessing the immediate value of the quantitative results allowances will be made for this difficulty.

I THE PICKING AND PACKING OF FRUIT

1 On the farms studied the best fruit pickers are between 25 and 45 years of age. The best pickers at one kind of fruit are the best pickers at all other kinds of fruit (pp. 18, 19).

2 Slow pickers could often increase their output rate by picking more than one fruit before bringing the hand back to the receptacle, by using both hands, by keeping the receptacle as near to the bush as possible and by refraining from "dodging about" (pp. 20, 23).

3 A special stool was devised and introduced by the investigator which proved extremely satisfactory in the picking of blackcurrants. This stool, which affords a comfortable seat at three different heights, has also been found useful in packing sheds, etc. It is simple and not expensive to construct (pp. 21, 22).

4 Bad picking, *e.g.* picking unripe fruit, may sometimes be due to ignorance or thoughtlessness ; it is by no means always due to want of conscientiousness (pp. 23, 24).

5 In fruit picking, including hop picking, there is no evidence to show that the afternoon rates of output are lower than those of the morning—in some cases they are higher (pp. 24, 25).

6 In picking strawberries—the most fatiguing of all fruit to pick—a fast picker spent 32 minutes of the hour in actually picking, 17 minutes of the hour walking from plant to plant with basket, 8·5 minutes in fumbling at the leaves, and 2·5 minutes in carrying in the load and returning (p. 26).

7 It is important, therefore, that the plants should be as close together as possible, that high-yielding types of plants should be selected, so far as possible, and that the packing shed should be in close proximity to the plants so as to reduce unproductive time (pp. 27, 28).

8 In hop picking the bin system is much more efficient than the basket system. In the measuring and bagging of the hops, 5 bushels were dealt with by the bin system in 20 seconds, involving the labour of only 4 people ; whereas by the basket system 70 seconds were taken, involving the labour of 6 people. The continuance of the basket system seems entirely due to local custom (pp. 28, 30).

9 One hop picker may pick nearly four times as fast as another (pp. 30, 31).

10 Children's nurseries should be established in hop gardens and fruit farms for the benefit of the children, the parents and the employers. The workers regarded this suggestion with favour and appreciation (pp. 32, 33).

11 By the introduction of a bench in the packing of bush fruit, a saving of 15·3 minutes on 200 "chips" (baskets) can be effected. But the principal benefit is the reduction of unnecessary fatigue (pp. 33, 34).

12 Glass-house workers should be small of stature, "nippy," immune to temperature changes, sympathetic towards and interested in delicate plants

and be possessed of nimble fingers and a quick and observant eye. Vocational selection and guidance in this and other forms of agricultural work are likely to prove advantageous (pp. 35, 37, 41).

13 It is uneconomic to convey tomatoes from the glass-houses of a large nursery in a wheelbarrow—a two-wheeled hand-cart is recommended.

14 Sinkage of the ground and the sill of the doors were found to make it necessary to unload tomatoes outside the packing shed in one case, and to take a circuitous route in another. Concrete gradients are recommended (pp. 37, 38).

15 Box-making should not take place at the same bench at which packing is in progress (p. 40).

16 A complete re-arrangement of work was recommended in a large tomato-packing shed, involving "departmentalisation." The owners are prepared to test the suggestions made (pp. 37–40).

17 In certain glass-houses and packing sheds it was found that on one occasion it took 4 hours 38 minutes of labour to pick and pack a certain quantity of fruit; of this time 55 minutes, or nearly 1 hour, was unproductive. In another case, between 10 a.m. and 4 p.m., 3 hours 50 minutes were spent in totally unproductive labour. The reasons were discovered and the waste shown to be largely preventable. It was not due to any desire to be idle (pp. 42–44).

II MILKING

18 The mean summer rate of milking of three milkers, with the same herd, was found to be 1·4, 1·2, 1·0 lbs. per minute for the morning, and 1·25, 1·0 and 0·9 lbs. per minute respectively for the afternoon. Milkers on other herds were found with higher mean rates (pp. 50, 55).[1]

19 Assuming that a milker is at the actual milking process for three hours a day, an increase of 0·2 lb. per minute means a saving of 30 minutes. It is possible to effect this increase (p. 48).

20 "Holding" of milk by the cow may reduce the rate by 50 per cent. of what it would have been without "holding" (p. 51).

21 A milker's rate on a very "hard" cow may be nearly a third of his rate on a very "easy" cow. Such "hard" cows, unless exceptionally heavy yielders, should be got rid of (pp. 53, 54).

22 The rates of women milkers studied were equal to those of the men milkers. Women were found to be more patient and cheerful with their cows than men, but not more so than boys (pp. 55, 57).

23 The rate of milking day by day on the same cow varied independently of the yield of milk; but other things being equal, the *mean* rate is higher on heavy-yielding cows over a period (pp. 58, 63).

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[1] Machine milking is not adopted on most farms either in England or America. The reasons are explained in the Report.

24 Warm weather—and especially flies—are factors interfering with the rate of milking and also with the yield of milk from day to day (pp. 54, 56).

25 Manual skill varies among different milkers ; there are possibilities in regard to their training in correct movements (pp. 57, 58).

26 The ordinary milking stool is not satisfactory, principally because it is not adjustable as regards height. Suggestions for an improved milking stool are made (pp. 63, 64).

27 The use of rubber gloves during rough work in winter is recommended (p. 64).

28 Certain inefficiencies of the " clean-milk " pail are indicated (p. 64).

29 Certain defects in artificial lighting in the cowshed are noted and suggestions made. Lighting should be central and diffused (pp. 64, 65).

30 In the afternoon production of " clean-milk " only 49 per cent. of the total time between fetching in the cows and despatching the milk is devoted to the actual process of milking under the conditions investigated (pp. 65, 66).

31 Time and labour would be saved by using a hose in washing down the cows (p. 66).

32 The spraying of the cows and shed with antiseptic is important in summer time as a means of getting rid of flies. It would be more efficient to effect this by gravity from a tank through pipes than by two men and a portable hand pump as was observed in practice (p. 67).

III MATTERS FOR FUTURE INQUIRY

33 The above work needs repetition and elaboration on a number of other farms in different parts of the country (p. 68).

34 Additional processes worthy of investigation are hoeing, " singling," planting cabbages, pulling mangels, harvesting wheat, and the methods of handling different kinds of farm animals (p. 68).

35 A few illustrations are given to show that the investigation of farm " lay-out " would be of value (pp. 68, 69).

36 The relations between farmers and workers, their attitudes of mind towards each other, and the different method of " handling " labour need investigation over a wide area (pp. 69, 70).

37 Agricultural co-operation also appears to be a matter for psychological inquiry (p. 70).

38 Results of far-reaching importance might be secured by the application of the methods of vocational selection and guidance to agriculture (pp. 70, 71).

I THE PICKING AND PACKING OF FRUIT

[A] THE PICKING OF BUSH FRUIT

1 *General Conditions of Work*

The picking of this kind of fruit, except strawberries, takes place during the hottest period of the year, namely in July. The fruit farm where most of the present observations were made is "late," and even strawberries are picked mainly in July. The fruit is picked exclusively by females, mainly married women. Great energy and perseverance are needed, especially for strawberry picking, and nimbleness of fingers is essential. Payment is by piece-work. The rate varies according to the kind of fruit, but 3*d.* per 5 lbs. picked may be taken as an average rate. Average earnings are from 4 to 5 shillings a day. To the farm visited for this work many of the women came considerable distances—several miles—daily. It is important to bear in mind that most of the women who engage in this and other kinds of agricultural work have household duties to perform as well, and that this is done both before coming to "work" and after leaving "work." Any efforts in the direction of making work easier for them on the farm are therefore important and keenly appreciated.

2 *Individual Differences in Output*

As is well known, the output of some pickers is always greater than that of others. It was desired to find out the extent of these individual differences—whether they are constant for different kinds of fruit and also, if possible, the reasons for the differences. The following table (Table I) shows the order of 21 pickers in respect of strawberry picking and loganberry picking. The order of most of the pickers is also given in regard to raspberry, blackcurrant and gooseberry picking, but too much weight must not be attached to these latter figures, as they cover a very short period, in some cases only half a day, compared with six or seven days in the case of strawberry and loganberry picking.

It is evident from the table that there is a very considerable degree of constancy. A very fast picker at one kind of fruit is usually very fast at all other kinds of fruit ; and a very slow picker at one kind of fruit is usually very slow at others. Strawberries require most skill and energy to pick ; loganberries least skill and energy. If there is a high degree of correlation between output for these two kinds it is likely to be general for all fruit. The coefficient of correlation[1] is 0·83 ; and this is highly significant, as its probable error is ± 0·02.

As regards the extent of these differences, the fastest strawberry picker's output, over a period of several days, was 39·6 per cent. above the mean of all pickers, and the slowest worker's output was 26·4 per cent. below the mean.

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[1] The closer the coefficient approaches unity, the more perfect is the correlation ; and when the coefficient is more than three times the probable error it is significant.

In the case of loganberry picking, the respective figures were 50·0 per cent. and 35·0 per cent. The coefficients of variability[1] among the 21 pickers are for strawberries 20·86 and for loganberries 22·26. The relative variability between pickers is therefore very considerable but is roughly the same for the two classes of work.

Although both employers and pickers are conscious of the existence of individual differences in output, it is questionable whether they realise how wide these differences are. The practical conclusion is that there must be some possibility of improving the slowest workers. For it is unlikely that the differences are entirely due to such constitutional factors as are entirely unalterable.

TABLE I

Showing the Order of 21 Pickers in Respect of Output for 5 Different Kinds of Fruit

Picker	Strawberries	Loganberries	Blackcurrants	Gooseberries	Raspberries
A	1	2	1	3	3
B	2	4	3	6	2
C	3	3	4	1	—
D	4	5	8	—	10
E	5	1	2	2	1
F	6	9	5	9	5
G	7	12	12	12	9
H	8	17	6	7	—
I	9	8	9	—	8
J	10	6	—	4	4
K	11	7	7	5	6
L	12	11	—	11	7
M	13	16	—	—	11
N	14	13	10	18	—
O	15	10	—	14	13
P	16	18	11	15	12
Q	17	15	15	8	14
R	18	19	—	16	—
S	19	20	14	17	—
T	20	21	—	10	—
U	21	14	13	13	15

3 *The Characteristics of the Fastest and Slowest Pickers*

An attempt was made to investigate the reasons for these individual differences. Two more or less distinct procedures were followed, (*a*) the personal characteristics of a large number of pickers were studied by questioning and observation, and (*b*) their actual methods of work were observed and analysed. During the conduct of the first line of inquiry, thirty-six pickers

[1] The coefficient of variability is a measurement of the extent to which a number of variants deviate from their mean.

belonging to different farms in Kent were questioned on the following points : age, height, weight, number of children, number in field, general health, meals (particularly whether breakfast was taken before starting work), effect of weather in the field, and expenditure of earnings (this information was obtained indirectly). They were also observed in regard to energy, talkativeness, cheerfulness, conscientiousness, and posture while at work in and about the field.

From these and other observations it appears that fast picking is associated with constitutional energy, suitable fingers and responsibilities of mature age and economic pressure.

4 *The Method of Picking*

(*a*) *Strawberries.* Apart from possessing greater energy and persistent concentration (temperamental characteristics), the fastest pickers usually employ better methods and are more skilful in executing them. In strawberry picking the best pickers (i) stoop and scarcely ever kneel, (ii) they quickly find the fruit hidden by leaves, (iii) they clip off the fruit, with a piece of stalk attached, with the thumb nail and forefinger nail, very quickly and deftly, (iv) they can use either their left or right hand, according to which is most convenient (or even both together very occasionally when the fruit is easily accessible), (v) they get a hand load of at least four average-sized strawberries before bringing the hand back to the receptacle they are filling, (vi) they never go back to a plant after they have passed it, (vii) they show no hesitation in selecting ripe fruit and in grading them into two sizes as they go along, and (viii) they can usually tell when they have picked 4 lbs. (the unit weight for which they are paid). With a good run of fruit a fast picker will actually pluck at the rate of about 16 strawberries in 30 seconds compared with a slow picker's rate of 7 strawberries in 30 seconds. Slow and medium pickers could in some cases increase their speed by giving special attention to the above points. In this investigation the writer was able to instruct one or two beginners who were pulling off the berries one by one (and many of them too green), out of sheer ignorance and thoughtlessness. Inquiry has shown in this investigation that experience and practice are important in fruit picking, but that after one or two seasons' work they cease to be determining factors as regards individual differences.

(*b*) *Loganberries.* In the picking of loganberries there is less difference in method and skill. There is no stooping. All pickers pull off each fruit with the thumb and first finger. A good picker, with a good run of fruit, will pluck ten loganberries before bringing the hand back to the receptacle and without moving her position. The slow picker "dodges" about and carries small hand loads to the basket or "chip," which she carries in her left hand. With a good run of fruit a good picker will pluck over 30 in 30 seconds ; a slow picker about 18 in 30 seconds.

(*c*) *Blackcurrants*. Blackcurrant picking is more complicated. A study of the methods in the field indicate that there is distinct scope for improvement even among fast pickers. Blackcurrants hang mostly in clusters or festoons. A good picker plucks off each cluster by the " strig " or stalk by means of the thumb and first two fingers at the rate of about 20 berries per 30 seconds (slow pickers, 8 berries per 30 seconds). It is essential to grasp the strigs, otherwise the fruit gets bruised or broken. The fruit ought to be picked branch by branch. If necessary each branch should be firmly grasped by the left hand and given a slight twist so as to present the fruit to the picker, who should then work systematically either up or down the branch until it is stripped. An indifferent picker often " dodges " about from one part of the branch to the other, and sometimes from branch to branch. It is necessary to work methodically and with patience. Sometimes it seems advisable to strip off some of the leaves before beginning to pluck a branch. Indifferent pickers *pull* off the berries without any stalk but often with a considerable quantity of leaf which has later to be picked out of the " chip " or basket.

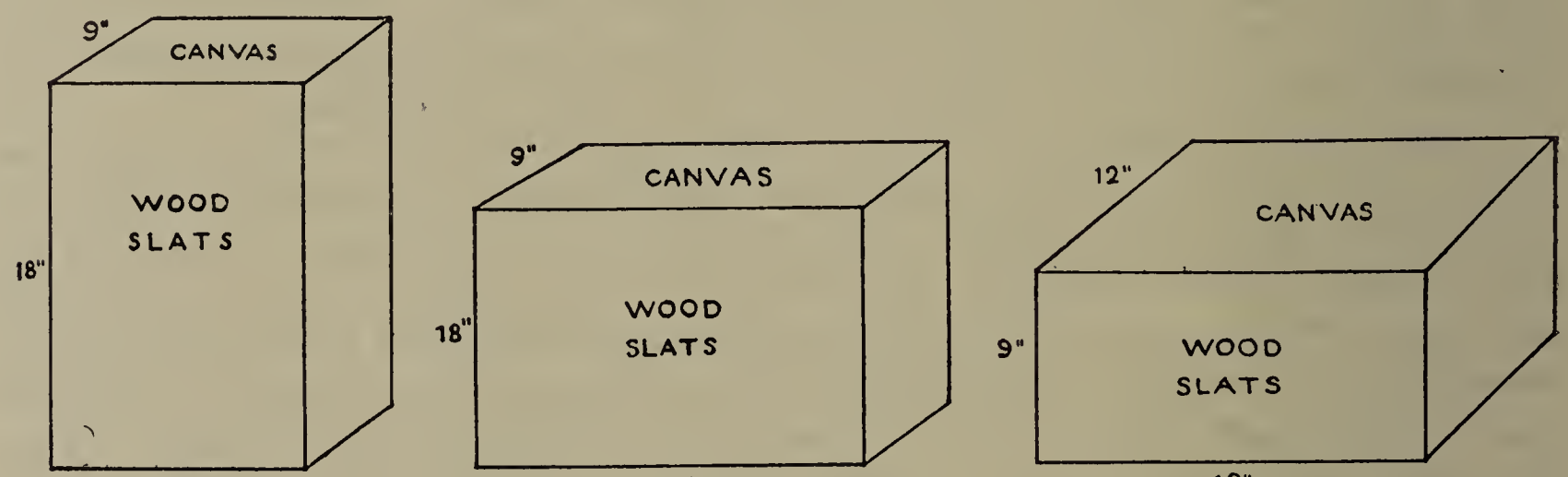
The position, shape and size of the receptacle are all important in the picking of bush fruit. The general plan with strawberries, currants and gooseberries is to use a basket called a " tray " with a central handle, containing four chips, each of which is capable of holding 4 or 5 lbs. of fruit. It is important to keep the tray as near to the picking point as possible, but even good pickers waste time and energy through being careless in regard to this point. Attention to it seems especially necessary in the case of blackcurrant picking. The tray or—if the soil be dry—a single " chip " should be placed immediately under the branch being dealt with. This not only reduces arm movement, but it prevents ripe berries from falling on the soil below, from which they have to be picked up individually afterwards. Some indication of the advantages of paying attention to these points is given by the following figures, which refer to the time taken by a slow and inefficient picker to pick respectively two similar bushes of fruit, first without and then in accordance with the writer's instructions :

Without instructions - - - - -	14 mins. 30 secs.
With instructions - - - - - -	10 mins. 30 secs.

The time required by a fast picker to strip a good blackcurrant bush is about 6 to 10 minutes, and this fact together with the height of the plant above the ground renders it possible to sit and thereby to save fatigue. A few pickers always make a practice of sitting where the run of fruit is good, but the majority kneel or bend. Even those who sit use old boxes or a bushel basket—difficult to carry around and not always particularly comfortable or suitable as regards height. There seemed to be need for a standardised and efficient stool. In Fig. 1 is shown a stool devised by the investigator that was constructed and tried successfully in the field. The essential features of this stool are as

follows : three of the six sides (each one of them having different dimensions) are " slatted " and the corresponding three are covered with strips of canvas. In any one of the three positions the " slatted " end rests on the ground, and the corresponding canvas end forms a seat. The output rate per hour throughout the day was determined for three pickers using these stools, and was compared with the output rate per hour for three similar pickers who had no seats at all. So far from there being any reduction in output among the seated pickers, there was a definite indication of increase (*cf.* p. 25). The most important result, however, was that the pickers using the stools felt more comfortable and appreciated the saving in fatigue. The foreman in charge, at the request of the pickers, has stated his intention of introducing these stools

FIG. I



The three positions of a box stool that was devised for use in the picking of blackcurrants

in subsequent years. It may be noted that the same form of stool has been found useful in packing sheds, etc. (*cf.* p. 34).

(*d*) *Gooseberries.* The best pickers (i) stoop or go down on one knee, (ii) use both hands if possible, putting the flat of the hand under a separate branch, gently clawing off the fruit in large numbers, (iii) they grade them almost unconsciously into two sizes, letting the berries trickle, as it were, through their fingers into the " chips." The reason for going under the branches with the hardened palm exposed is to avoid being pricked by the spines with which a gooseberry branch is studded. A certain amount of fear is manifested by the novice, who picks one fruit at a time and seems to be thinking more of avoiding the spines than of getting quickly at the berries. The correct idea is " to grasp the nettle firmly." Occasionally pickers use gloves ; but most pickers say that gloves are a handicap. It is possible that the expense and trouble of gloves are contributory reasons for their non-employment. Where the gooseberry bushes are large, it would probably be practicable to sit while

picking. Most bushes, however, do not take more than three minutes to strip.

(*e*) *Raspberries*. It has been the experience of the investigator that raspberry picking is a source of constant annoyance to fruit pickers. It is not physically, but mentally fatiguing. The run of fruit has to be very good for a fast picker to pluck more than 12 in 30 seconds. Often the number of ripe berries is so few and scattered that not more than 6 are picked in 30 seconds. And considering that each berry has to be gently pulled or twisted off with the utmost care owing to its delicate structure and carried individually to the "chip," it can be readily understood that raspberry picking as a general rule is not popular at the rates usually paid for this kind of work. It is a great mistake to put pickers on to raspberries in the late afternoon when they are fatigued and hot and their patience is giving out. Temperamental qualities rather than skill seem important in raspberry picking. The writer was present on one occasion when the pickers "struck." The cause was entirely due to overtaxed patience. The first symptom was an excessive amount of talking in the field and a considerable amount of laughing. The fastest of the pickers under observation surprised the writer by calling out for someone to give a cheerful song. This woman usually did her seven hours' work a day in complete silence and reserve. These incidents are recorded as they have a bearing upon mass psychology in the field.

5 *Acts of Decision in the Picking of Fruit*

In the foregoing sections several references have been made to processes which call for acts of decision. The subject is important and may be considered now in more detail. Definite decision during fruit picking is called for in respect of (i) which fruit *not* to pick, (ii) field grading, and (iii) weight. Under (i) we have to distinguish between (*a*) ability to perceive (immediately) what *not* to pick, *i.e.* unripe fruit, and (*b*) the natural temptation or unconscious tendency to pick something so as to get the basket full. This latter is often hard to control, as the writer himself has found. It is an important point, because it indicates that a picker may bring in unripe fruit, not as the result of any deliberate intention to defraud, but rather as the result of an irresistible or unconscious response to the situation of there being "something present to pick." It is often a question of weak will-power rather than of lack of conscientiousness. Green fruit brought in may be due to lack of knowledge as to the dividing line between ripe and unripe. Here instructions and training are likely to be of value. In the picking of loganberries and raspberries there appears to be scope for what may be called "group decision." The ripe fruit is scattered, but it may be so presented to the observer that at one glance the approximate number and position of the ripe fruit can be taken in. It would seem that by this method a number of decisions might be replaced by one single general decision, the immediate "field" of picking surveyed and

the rate of picking being thereby increased, with a reduction in the mental fatigue which a large number of decisions entails.

In regard to (ii), *i.e.*, decisions in respect of grading, the pickers are, as has been already mentioned, usually required to place the larger fruit in one receptacle and the smaller in another, as they carry the hand-load from the plant. Some pickers effect this without conscious effort, whereas others, especially beginners, show visible hesitation. It is certainly a factor influencing output ; and although experience tends to cause improvement, it is possible that practice could be more expeditiously secured as the result of training young workers at home by means of artificially constructed berries.

Under (iii) the picker has to decide when the receptacle contains its proper weight of fruit—4 lbs. in the case of strawberries, and 5 lbs. in the case of blackcurrants. If a mistake has been made, it leads to waste of time ; for either the picker has to make good the deficiency (if there is an excess, the farm takes it) ; or, according to an alternative system, any excess or deficiency is adjusted by the weigher in the packing shed while the picker waits. All this could be obviated by the picker using a small spring balance, or better still by the picker training herself at home by means of such a balance. Sufficiently accurate judgments of weight can usually be acquired ; but cases have been observed where experienced pickers are totally incapable of forming reliable judgments in this respect.

6 *Output and Fatigue*

It is difficult to secure satisfactory data showing hourly output, first because the run of fruit varies considerably, and secondly because of interruptions and difficulties as regards measurement. The following tables, however, are of some interest. The figures relating to strawberry picking (Table 2) are the most reliable.

TABLE 2

Showing Hourly Output (lbs.) in the Picking of Strawberries.

Picker	10 a.m.	11 a.m.	noon	2 p.m.	3 p.m.	4 p.m.	5 p.m.
A	11	22¾	11¼	13½		17	8
X*	15½	16¾	14	19¼	Broke off	21	13
Y*	6¼	3¾	5	10½	to attend	12	9
D	12	13¾	8¼	12	wedding	16¼	9¾
E	10	8	6	9½	in village	11	7
F	12	12	5	16		21	11
G	10	8½	5½	11		12	7
Z*	11	10¾	11¼	15½		18	15

The asterisk indicates that X, Y and Z represent pickers not engaged in the picking of blackcurrants. (See following Table.)

TABLE 3

Showing Hourly Output (lbs.) in the Picking of Blackcurrants.

Picker	10 a.m.	11 a.m.	noon	2 p.m.	3 p.m.	4 p.m.
A	8	5½	10½	11½	12	13 (s)
B (s)	6	5	6½	6	6½	10
C	5	5	7	7½	8½	9
D	8	16	15	9¾	14¼	11 (s)
E (s)	6½	5	17	9	8	10
F (s)	8½	12	17	7½	12	16½
G	6	6½	6½	7½	7½	7½ (s)

The letter (s) indicates that the picker was seated on the stool devised by the investigator (see p. 22). Pickers B, E and F used the stools until the last hour of the afternoon, when they were transferred to pickers A, D and G with the object of seeing whether the stools were appreciated by the tired workers to whom they were given. This experiment resulted in the workers making a definite request to the foreman to be supplied with these stools. It will be noticed that the three pickers who had been seated during the day picked on the average considerably faster in the last hour of the afternoon than those who had hitherto not been seated. This is scarcely likely to be a coincidence, although there is a general tendency towards increased output during the last hour both of the morning and of the afternoon, which is probably to be explained in part by the run of fruit being at least 25 per cent. better for all pickers later in the day than in the early morning.

Another factor influencing the afternoon output is no doubt the rest-pause which the workers took at 3 p.m. A general impression seems to prevail on fruit farms that the rate of output is greater rather than less in the afternoon. The results of this investigation are somewhat inconclusive in this respect ; but it is perhaps worth mentioning that some pickers take little or no breakfast before starting work. Of 36 pickers questioned, 7 stated that they took nothing at all until dinner (at noon). It is likely that the output rate of these would be higher in the afternoon than in the morning ; but so much depends on constitutional energy and skill and on the run of fruit, that a large amount of observation and measurement is needed before the exact truth can be arrived at.

Generally speaking, fruit pickers feel fatigue most at the end of the *week* rather than at the end of the *day*. It is probable that the output rate falls on Thursday and Friday.

Weather has an important influence on fatigue. The signs of fatigue are especially noticeable on very hot days. During this investigation a gang of pickers were supplied with white handkerchiefs to wear over the back of their necks, with beneficial results. This was done after one case of sunstroke and two other cases of heat exhaustion which occurred on a very hot afternoon (July 14).

7 *Unproductive Time*

So far the differences between pickers as regards their qualities and methods and output have been considered. We will now consider what proportion of the time spent in doing a normal day's work is unproductive. There are clearly two processes in the picking of fruit which are productive : (*a*) the actual plucking and grading of the fruit, and (*b*) the conveyance of the fruit to the nearest and most appropriate point for packing and despatch. Time spent on other movements or processes is unproductive. If such expenditure of time is avoidable, it is wasted ; if unavoidable, it is a necessarily wasteful cost of the operation.

It will be sufficient for the purpose of this section of the Report to consider the matter in connection with the picking of strawberries.

Actual records show that the rate of output in strawberry picking varies usually between 10 and 18 pounds per hour among a large number of pickers working on a uniform and moderately good run of fruit. The latter figure may be taken as the average rate of a very fast picker and the former figure that of a very slow picker. Attention will be confined first to the fast picker.

(1) In this investigation it was determined : (*a*) that a very fast picker " plucks " at the average rate of 16 fruit per 30 seconds (including the depositing of the fruit in the basket or " chip " ; (*b*) that the average fruit weighs 8 grams[1] ; (*c*) that each plant, during a single day's picking, yields on an average 5 fruit ; (*d*) that a fast picker spends about 12 seconds on each plant.

Now if all the picker's time were spent in actually picking or 'plucking,' she could get $\left(\frac{8 \times 16 \times 3600}{454 \times 30} =\right)$ 34 pounds in 1 hour. But she actually gets only 18 pounds in one hour. Hence she is actually picking for $\left(\frac{18 \times 60}{34} =\right)$ 32 minutes.

To get 18 pounds she has to visit $\left(\frac{18 \times 454}{5 \times 8} =\right)$ 204 plants. She spends 12 seconds at each plant, of which 3 seconds are spent in fumbling the leaves to find the fruit. Therefore $(204 \times 12 \div 60 =)$ 40·5 minutes are spent at the plant, of which 8·5 minutes are spent in fumbling ; and hence $(60 - 40 \cdot 5 =)$ 19·5 minutes are spent in walking from plant to plant, *less* 2·5 minutes spent in carrying in a load of fruit and returning.

This result may be summarised thus :

Actually picking - - - - - - - - -	32·0 mins.
Carrying in and returning (average journey) - - -	2·5 „
Walking from plant to plant with basket - - - -	17·0 „
Fumbling with leaves, etc. - - - - - - - -	8·5 „
	60·0 mins.

[1] 454 grams = 1 lb.

This is approximately the time analysis of a very fast strawberry picker on the principal fruit farm where these studies were made. Assuming that the packing shed was as centrally situated as possible and that the fruit was promptly received from the picker, 34·5 minutes represent productive time and 25·5 minutes represent unproductive time.

(2) We may now consider the case of a very slow picker whose average plucking rate is, say, 9 fruit per 30 seconds.

If all her time were spent in actually plucking she would get $\left(\frac{9\times 8\times 3600}{454\times 30}=\right)$ approx. 19 pounds per hour. But she actually gets only 10 pounds per hour. Hence she is actually plucking $\left(\frac{10\times 60}{19}=\right)$ approx. 32 minutes. To get 10 pounds she has to visit only $\left(\frac{10\times 454}{5\times 8}=\right)$ 114 plants.

She spends 25 seconds at each plant, of which 8 seconds are spent in fumbling. Therefore (114 × 25 seconds=) 47·5 minutes are spent at the plants, of which 15·5 minutes are spent in fumbling, and hence 12·5 minutes are spent in walking from plant to plant—less 1·5 minutes spent (per hour) in carrying her load and returning (she goes in every 1½ hours against every hour for the fast picker).

Summarising, we have :

Actually picking - - - - - - - - - -	32·0 mins.
Carrying in and returning (average journey) - - -	1·5 „
Walking from plant to plant with basket - - - -	11·0 „
Fumbling with leaves, etc. - - - - - - - -	15·5 „
	60·0 mins.

In comparing these figures with those for the very fast picker, it is important to bear in mind that the slow pickers visit only 114 plants in the hour, whereas the fast picker visits 204 plants in the hour. The slow picker takes 9·6 minutes to walk between 100 plants ; the fast picker 8·3 minutes. This difference and the difference as regards "fumbling and hesitation" have nothing to do with the skill of picking and are capable of being reduced merely through greater exertion.

It is of course obvious that while the 32 minutes spent by each picker in plucking is productive, the 32 minutes of the fast picker is very much more productive than the 32 minutes of the slow picker. The reduction of the difference, to any great extent, is difficult since it is largely a question of skill. On the other hand, a slow picker could often increase her rate of plucking by paying attention to hand-load, to the use of both hands, and to other points discussed in previous sub-sections of this part of the Report.

As regards the plants and their arrangement, it is clear from the above

figures that fruit growers might reduce picking costs by concentrating on (*a*) increasing the yield per plant, (*b*) laying out the plants as close together as possible, (*c*) getting the packing sheds situated at the most convenient points in relation to the general layout of the beds. There is often room for improvement in these respects.

[B] THE PICKING OF HOPS

Hop picking has not been studied with any great degree of thoroughness, but the work possesses so many points of special interest that it has been thought well worth while to devote a section of this Report to an account of the main observations that have been made.

1 *General Observations*

Hop picking takes place during the relatively cool and fairly dry month of September. Of all other kinds of fruit picking it involves the expenditure of by far the largest number of man-hours per acre, and the cost of picking and drying hops is often more than half the total cost of production. As many as a thousand pickers may be found working and residing on a single farm during the season. The majority of these consist of casual labour, mainly from the East End of London, and there is also a fair number of local people. This contact between the town and country workers and between workers of different status presents opportunities for interesting observations.

It is important to remember that hop-picking has come to be regarded by the town pickers as the means of a cheap holiday. Many of them are satisfied if they cover their expenses. It is not physically fatiguing work : in contrast to strawberry picking, it is extremely light work. The picking, which is paid by piece-rate, is carried out by families or by groups of friends, each family or group usually, though not always, picking into a common receptacle and sharing the financial proceeds on the basis of mutual agreement. A good picker will earn 5*s*. a day.

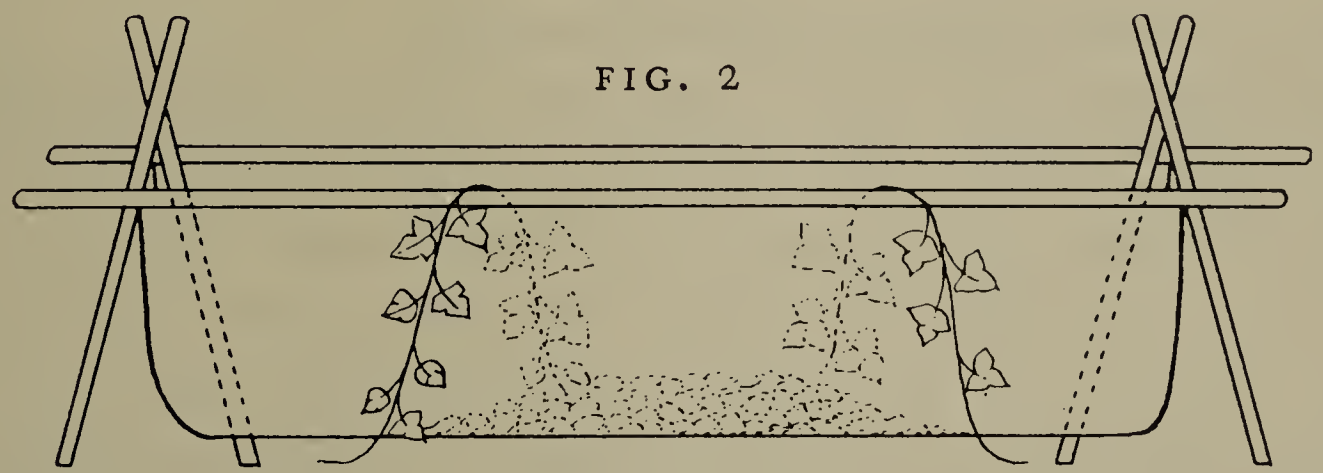
2 *Different Systems of Picking*

In the county of Kent there are two systems of picking—(i) the bin system, and (ii) the basket system. The former is the one principally employed. Its essential features are as follows : Each picker or group of pickers is supplied with the large wood and canvas receptacle (or bin) shown in Fig. 2, of which the weight (empty) is 50 lbs., and the dimensions are approximately 6 ft. × $2\frac{1}{2}$ ft. × $2\frac{1}{2}$ ft. The bines bearing the hops are pulled down from the overhead wire structure as required, and are usually laid across the top of the bin as shown. The hops are picked off it directly, or portions of bine are broken off and picked separately. By means of the handles two pickers shift the bin up the row periodically (about once every hour) as the bine near the

original position becomes used up. Periodically a booker and a tallyman come round, accompanied by a labourer who has previously placed large sacks equidistantly along the line of bines. The tallyman carries a bushel basket, by means of which he scoops out the hops from the bin and pours them into one of the sacks held by the labourer. The booker records the quantity in his own book and also on the picker's card. The booker also carries cash and pays the worker periodically. A second labourer follows him and ties up the open end of the filled sacks with string. They are then ready to be collected by the waggons and are taken to the " oasts " to be dried.

In the second or basket system, the pickers pick into anything they care to bring with them—baskets, boxes, parasols, iron baths, etc.—all usually of small dimensions. Opposite each picker's alley the booker places a large five-bushel basket graduated by means of five circular marks. As in the other

FIG. 2



Bin used in hop picking

system, the booker comes round periodically, and each picker—sometimes with assistance—empties his or her smaller baskets or boxes of hops into the five-bushel basket. The total volume is recorded as in the first system, whereupon the hops are transferred from the five-bushel basket into large sacks. These are tied up as before. This basket system is common in East Kent.

The bin system is typical of Mid-Kent, where the largest acreage lies. For several reasons the bin system is the more efficient :

(*a*) It dispenses with the handling of a large number of small receptacles, including the carrying of them by the pickers to the tally-point.
(*b*) The bines are picked immediately over the mouth of the receptacle, thereby obviating horizontal arm movements.
(*c*) It permits of ten bushels of hops being measured and transferred to a sack in one continuous series of motions at the rate of five bushels in 20 seconds: whereas by the basket system not more than five bushels can be measured and sacked at one time, and then only at the slow rate of five bushels in 70 seconds (60 seconds being the time of the picker filling the five-bushel

basket, which does *not* include the time taken in carrying up the loads from the picking point).

(*d*) It dispenses with the need for individual seats, since the pickers when they want to sit can rest on the rail of the bin ; in the basket system every picker has a chair or stool which she brings herself.

(*e*) In the bin system the picker keeps drier in wet weather, because the bine is laid across the bin instead of over the picker's lap.

The persons employed in tallying under the two systems respectively are as follows :

BIN SYSTEM	BASKET SYSTEM
1 booker (also paying cash).	1 picker or more filling five-bushel basket.
1 tallyman emptying, measuring and filling.	1 booker.
1 bagman.	2 men holding sack.
1 tier.	1 lad emptying five-bushel basket into sack.
	1 tier.

The labour economy of the bin system is obvious.

Custom is stated to be the principal reason for the non-employment of the bin system in East Kent. This would seem to be true, for at one point a hop garden in Mid-Kent was found to be using the bin system, while across the road another garden was employing the basket system. It is true that the *rate* of pay is rather higher in the case of the basket system (which is only fair since the worker has less time to spend in actual picking) ; on the other hand, the daily *earnings* are on the average considerably higher with the bin system because the output per day in so much greater. But the real advantage of the bin system, from an economic point of view, is the general saving in total labour and in supervision expended per unit measurement of hops. The unit cost of picking is less in the case of the bin system, assuming the yield per acre to be constant. It should be mentioned that several pickers questioned in East Kent said that they regarded the system of measurement in the basket system as fairer, or, rather, as more under the supervision of the picker. On the other hand, at least one case of dissatisfaction in connection with measurement in the basket system was encountered by the writer during this investigation. The general impression he reached was that the whole matter is mainly a question of custom and therefore can be altered in time.

3 *Individual Differences among the Pickers*

The subject of individual differences may be considered under two heads, (*a*) differences in output, and (*b*) differences in methods. Individual differences in output are difficult to measure because generally a whole family contributes to a common receptacle. Further the number in the group is constantly varying. The children may pick for half an hour, and then begin to play, or more frequently cry. Or one or more friends may suddenly arrive from London and put in an hour for sociability's sake, and so on. Again, as in the

picking of bush fruit, there is the factor of some variation in yield in different parts of the field. In addition there are carry-overs as regards measuring up.

In this investigation some idea as to differences in individual output was obtained by two different methods. (*a*) Groups were asked what was their output for the previous day and also in what proportion they would share the proceeds on the basis of what they considered their individual rates of picking. (*b*) Different individuals were each given a piece of bine on which the number of hops had been counted and were asked to pick it, the time being measured with a stop-watch.

The following figures (Table 4), referring to six pickers (two at each of three bins), were obtained by method (*a*) and may be regarded as reliable. Their own opinions as to personal differences were checked by means of method (*b*), and were found to be approximately correct.

TABLE 4

Picker	Sex	Age	Morning Rate Bushels per hour	Afternoon rate Bushels per hour	Remarks
A	F	38	3·3	4·4	Assessed themselves equal.
B	F	29	3·3	4·4	
C	F	64	1·8	1·7	
D	M	62	1·1	1·3	Bad eyesight.
E	F	40	4·0	3·2	
F	F	12	1·3	1·4	
		Mean	2·5	2·7	

The normal working day is from 7 a.m. to 4 p.m. with an hour for dinner ; *i.e.*, it is one of eight hours. The mean of 2 · 6 bushels per hour for eight hours gives 20 · 8 bushels per day. At 1*s.* per five bushels this yields 4*s.* 2*d.*, which is about the average day's earnings in West Kent, where the above measurements were made.

The above table brings out three points of interest :

(*a*) the existence of nearly 300 per cent. difference in individual rate of picking :

(*b*) a possible relationship between age and output ;

(*c*) a suggestion that the rate of output is generally higher in the afternoon than in the morning.

The following figures illustrating individual differences in both East and West Kent were recorded :

Counted Branch	Observed Rates during Ordinary Picking.
300 per minute	100 per minute
416 ,, ,,	71 ,, ,,
177 ,, ,,	100 ,, ,,
210 ,, ,,	64 ,, ,,
	170 ,, ,,
	120 ,, ,,
	65 ,, ,,
	49 ,, ,,
	109 ,, ,,

The higher rates in the first column are due to the fact that the pieces of bines given to the pickers were thickly covered with hops.

The second column represents the normal rate of picking. It may be noted that the very slow picker (49 per minute) was a young man of about 25 in first-class condition. Men, on the average, certainly pick more slowly than women.

4 *Methods of Picking*

From the figures given above it is obvious that the hand and finger movements are exceedingly rapid in hop-picking. Very fast picking, however, is not usually very clean picking. In other words, in very fast picking with ordinary bine, say, at the rate of over 200 per minute, it is impossible not to "strip" off the hops without a fair proportion of leaf. In West Kent the picking seems to be faster than in East Kent; but the East Kent hops are cleaner, *i.e.* freer from leaf. A picker who is both fast and clean is a skilled worker who is interesting to watch. The eye and the hand and finger movements are very highly co-ordinated. An effort is always made to take off as many hops at a time as possible, and the hops are seized underneath at the stalk end. The central body of the hop is not touched; this is to avoid damaging it. Considerable skill is displayed in avoiding the leaves during picking. Some pickers strip off some of the leaves first. In the bin system some pickers deliberately pick "dirty," and spend half an hour before tally time in picking out leaf. This does not appear to be an economical method working.

In the bin system, fast pickers sit occasionally when tired, but for the most part they work standing. It will be remembered that a tendency to keep on the feet is a characteristic of fast pickers of bush fruit also. The tendency is quite general. In the basket system, nearly every picker works seated, with the bine across her lap or on the ground beside her. This is probably one reason for the slower rate of picking under the basket system.

A feature of hop picking which is distasteful to the pickers is the periodical collection from the ground of the hops that have dropped off the bines or have been scattered in other ways. An attempt is often made to get the children to do this job. The children, however, dislike it. Scattering seems difficult to prevent.

5 *Children*

In both hop and bush fruit picking young children present a problem. In hop picking they do a certain amount of productive work, but in bush fruit picking none. In both cases they are a nuisance and undoubtedly tend to reduce their mother's output. In fruit picking young babies are frequently brought to the field in perambulators; and it is not uncommon for two or three hours of the mother's time to be wasted in trying to stop their crying. The crying also has a bad effect on the other pickers. Actual evidence of this

was obtained during this investigation. The remedy seems to lie in the establishment of field nurseries. Shelters might well be erected, and reliable girls engaged at a small daily wage to look after the younger children. Pickers who were questioned on the matter agreed, without exception, that such nurseries would be greatly appreciated.

[C] THE PACKING OF STRAWBERRIES, LOGANBERRIES, ETC.

1 *General Conditions of Work*

The study of the packing of bush fruit was carried out under some disadvantage, because it was not found possible to visit any packing centre where fruit is dealt with in great quantities. The two places where packing was studied consisted of small fruit farms where the daily despatch would not be more than 200 chips (of 4 lbs. each), and where this quantity was handled in the packing shed by not more than two persons. It was possible, nevertheless, to make some interesting observations, and to offer several suggestions which, when put into practice, resulted in the saving both of time and energy.

The principal operations in the packing of bush fruit, as observed, are—(i) weighing each "chip" of fruit (of 4 or 5 lbs.) and adjusting its weight ; (ii) stamping the lids with the address of the consignee ; (iii) putting on the lids ; (iv) placing rubber bands round each end of the chip ; (v) depositing the finished chip on a pile ready for despatch. Of these (i) is usually done as the fruit is brought in by the picker ; (ii) is done at odd times ; (iii) (iv) and (v) are done consecutively. The time taken for each operation can be easily measured.

2 *Introduction of Bench and Seats*

At the larger of the two fruit farms visited, the packing sheds consisted of improvised shelters, 12 × 9 × 7 ft. high. The earth floor was covered with a layer of straw and all the work was done at the level of the ground. It was suggested by the investigator that a bench should be provided. This suggestion was carried out in spite of some opposition on the part of the foreman, who seemed to think that it would get in the way. The following measurements (Table 5) were made on different occasions before and after the bench was introduced :

TABLE 5

Packing Ten Chips : operations (iii) (iv) and (v)

	At the ground level	On the bench
Woman Packer - -	2 mins. 38 secs.	2 mins. 13 secs.
Man Packer - - -	3 „ 41 „	2 „ 40 „
Man Packer - - -	3 „ 5 „	2 „ 20 „
Man Packer - - -	3 „ 45 „	2 „ 51 „
	Mean = 3 mins. 17 secs.	2 mins. 31 secs.

This represents an average saving of 46 seconds on every ten chips or 15·3 minutes on every 200 chips, a saving of over 23 per cent., which might well be important during a rush to catch a train at the end of the day. But the most striking benefit derived from the use of a bench in this work was the saving of needless fatigue. In the words of a female packer—" I felt a different woman at the end of the week after the bench had been introduced."

Suggestions were subsequently made by the investigator in regard to the position of the bench. This was so placed by the foreman as to form a kind of counter at the entrance ; but it blocked up the entrance so completely that those going in and out had to climb over it. By pushing it in a foot towards one side, the necessary gangway was provided. This seemingly trivial, common-sense detail is recorded to show how little attention is given by the worker to points of efficiency.

In addition to the bench, a couple of the special stools described under blackcurrant picking (page 22) were introduced. These stools were found convenient and comfortable during such operations as booking.

3 *Flow and Arrangement of Material*

In only one shed was an entrance provided at the back as well as at the front, so as to allow of delivery at one end and despatch at the other. Very little attention seemed to be given to the methodical arrangement of material. On several occasions delay resulted from congestion and muddle. No effort to use vertical space by means of shelves could be noticed.

4 *Situation of the Sheds*

In the two fruit farms visited in this investigation, the sheds were fairly well situated. In other words, the time required to carry in the fruit from the fields seemed to be reduced to a minimum so far as road facilities for despatch would allow.

5 *Keeping the Pickers Waiting*

As pointed out in the section on fruit picking, time is important to pickers of bush fruit, who are mainly married women with household duties to perform on reaching home. Those who go home to dinner usually " knock off " at 11.50 a.m. to give themselves time to prepare their husband's meal by noon or shortly after. On one occasion, during the picking of blackcurrants the pickers were kept waiting owing to the system obtaining on one farm of weighing the chips brought in and allowing for excess or deficiency (over or under 5 lbs). At the second of the two farms where observations were made, the pickers were kept waiting for 15 minutes at the end of the day (6 p.m.) owing to confusion in the packing shed.

[D] THE PICKING, GRADING AND PACKING OF GLASS-HOUSE PRODUCE (MAINLY TOMATOES)

1 *Introductory*

The work and arrangement involved in the handling of tomatoes and other glass-house fruit are of a self-contained and specialised nature. It is therefore desirable to devote a special section to this important and highly capitalised branch of market gardening.

The work was mainly investigated (*a*) on a small horticultural establishment (Nursery 1), and (*b*) at a much larger and more strictly commercial concern situated in another part of the county (Nursery 2). It should be unnecessary to point out that the production of tomatoes, cucumbers and such flowers as chrysanthemums under glass is an important industry in England, especially in the Lea Valley, at Worthing, etc. It is also an important continental industry, notably in Holland. The permanent capital investment may be as much as £10,000 per acre, and the net profit on capital may be from 30 to 40 per cent. per annum.

2 *Method of Picking and Individual Differences*

The best lay-out of tomato plants for picking appears to be that shown at D (glass-houses) in Fig. 4 (page 36). Here the plentiful supply of pathways and spaces renders the fruit easily accessible, and there is no reason why the receptacle should not be kept close to the picker, thereby avoiding those wasteful journeys with hand-loads so commonly to be observed under the conditions shown in Fig. 3 B. Within limits, wide planting gives as high a total yield of fruit as close planting : hence there seems to be no horticultural necessity for stinting the space available for moving between the plants.

Tomatoes are picked by breaking them off individually, with a slight upward pressure, at the joint on the stalk just behind the fruit. With practice, the tomatoes can be broken off very rapidly in this manner. Fruit for the London (or any distant) market has to be picked slightly green at the base. For local sale the fruit is picked red. This involves acts of decision, to the importance of which attention has been already called in this Report.

The picker uses either a light box capable of holding about 17 lbs. of fruit, or a round basket which holds about 12 lbs. Each kind of receptacle has its own advantages. It seems to the investigator possible that a receptacle combining the advantages of both might be devised.

There is a considerable difference between pickers in the rate of plucking. Comparison by measurement is difficult on account of the variation in the run of fruit. The following figures, however, referring to three pickers in Nursery 1, are fairly reliable :

Picker A. Five tomatoes plucked in 6 seconds.
Picker B. Five tomatoes plucked in 15 seconds.
Picker C. Five tomatoes plucked in 19 seconds.

FIG. 3

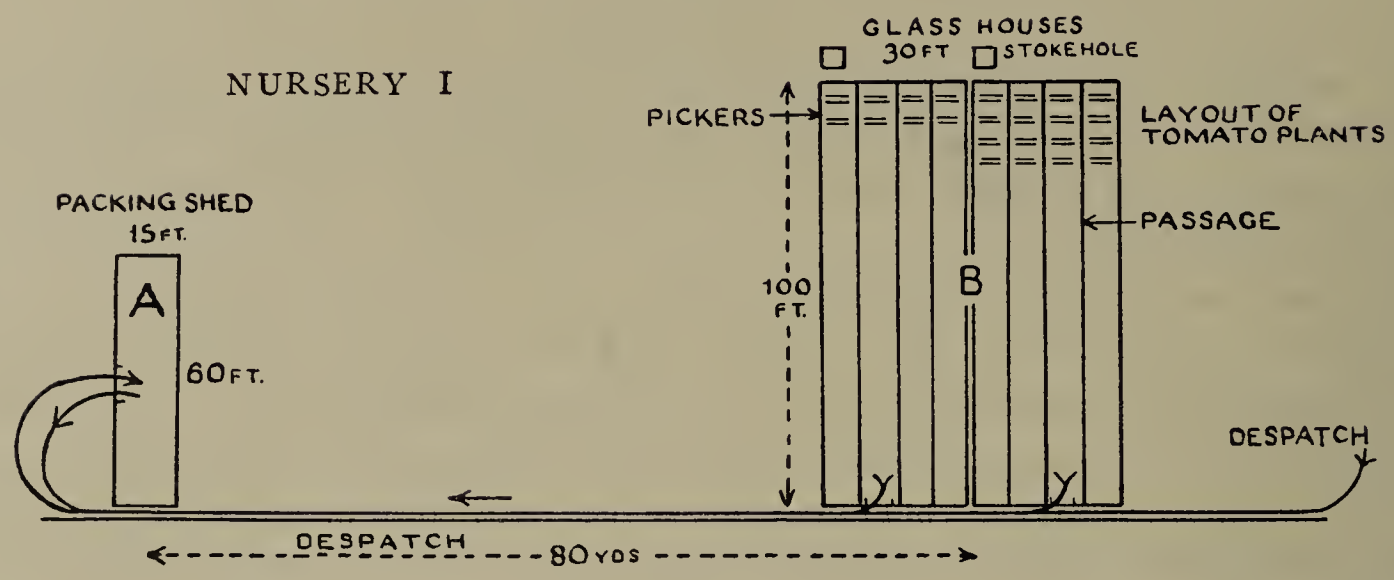
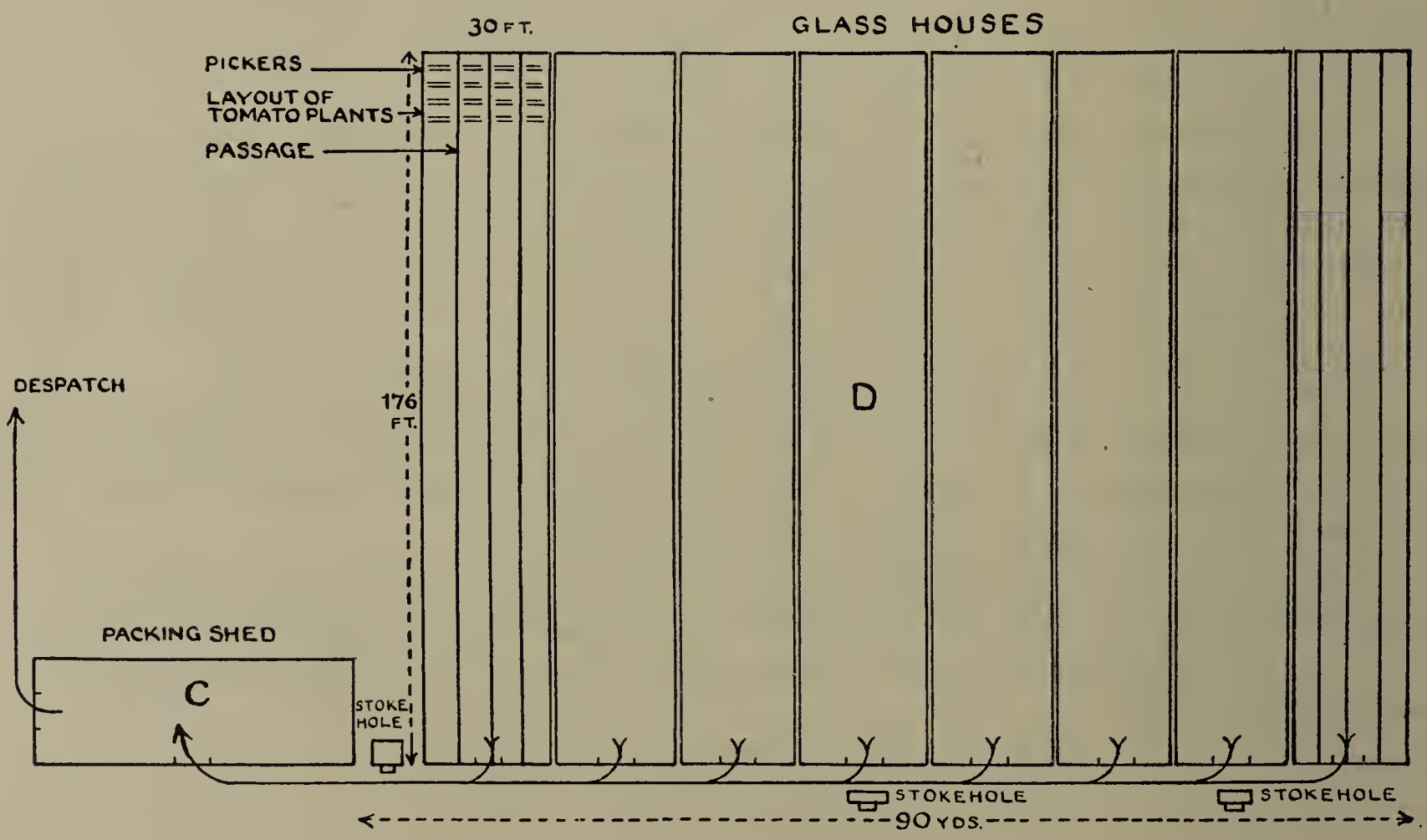

NURSERY I
GLASS HOUSES
30 FT
STOKEHOLE
PICKERS
LAYOUT OF TOMATO PLANTS
PASSAGE
PACKING SHED
15 FT.
A
60 FT.
100 FT.
B
DESPATCH
DESPATCH
80 YDS

FIG. 4


NURSERY 2
30 FT.
GLASS HOUSES
PICKERS
LAYOUT OF TOMATO PLANTS
PASSAGE
DESPATCH
176 FT.
D
PACKING SHED
C
STOKE HOLE
STOKEHOLE
STOKEHOLE
90 YDS.

Some allowance must be made for a slightly better run of fruit for Picker A at the time when the observations were made, but the differences are broadly trustworthy. Picker C was an unskilled worker, unpractised at the job.

The following figures refer to four pickers in Nursery 2 :

Picker 1. Five tomatoes plucked in 8 seconds.
Picker 2. Five tomatoes plucked in 10 seconds.
Picker 3. Five tomatoes plucked in 12 seconds.
Picker 4. Five tomatoes plucked in 7 seconds.

Allowance must be made in this case also for a rather better run of fruit in the side rows where pickers 1 and 4 were working ; but the differences in rates indicated are substantially reliable. The rates in Nursery 1, however, are not strictly comparable with those in Nursery 2.

3 *Qualities Needed in Glass-House Pickers*

The conditions of glass-house work are so artificial and unusual that it is only to be expected that special qualities are needed for successful work under them.

It would appear that the ideal picker should be :

(*a*) of small stature—tall men take up too much room and are usually clumsy ;
(*b*) capable of working without discomfort in a warm and humid atmosphere and of withstanding the effects of sudden changes on going outside ;
(*c*) constitutionally sympathetic towards and interested in delicate plants ;
(*d*) possessed of nimble fingers and a quick and observant eye.

Persons unaccustomed to glass-house work find it very trying, especially between June and September (inclusive). Women temporarily working in the glass-houses of Nursery 1 complained of the " heat " when the temperature was only 62 F. One of the boys employed at Nursery 2 could not work in the glass-houses without suffering from nausea.

4 *Routing the Tomatoes to the Packing Shed*

Several defects in the routing of the fruit were observed during the present investigation. The direction of flow is shown in Figs. 3 and 4. The defects in the case of Nursery 1 are three :

(*a*) The fruit is frequently carried by *two men* on a tray, whereas it could be more easily transported by *one man only* in a two-wheeled cart.
(*b*) The fruit is taken in round a side gate and through a side door (see Fig. 3, A), whereas it might just as easily be taken in at the bottom door.
(*c*) The trips are not always well regulated ; instances were observed where the grader and packer were needlessly kept waiting in the packing shed.

The defects observed in regard to the packing shed of Nursery 2 (see Fig. 4, C) were as follows :

(*a*) The baskets of tomatoes are brought from the glass-houses to the packing shed (see Fig. 4, C) in a wheelbarrow. This wheelbarrow has been arranged to carry a good load (144 lbs. of fruit), but this type of vehicle puts unnecessary strain on the worker. He has to push instead of pulling ; and he has to stoop in order to keep the legs of the barrow only an inch or two from the ground, so that the top baskets do not topple forward. A two-wheel vehicle would carry a bigger load and put less strain on the worker.

(*b*) On arriving at the packing shed the wheelbarrow has to be unloaded outside and the baskets have to be carried inside. The barrow cannot be wheeled in because there is a sill and a layer of brickwork at each entrance, above the level of the ground outside. This means a considerable waste of time and effort.

All the above defects could be easily remedied. In Nursery 2 the suggestions just mentioned were accepted and the necessary alterations will be made.[1]

5 *System of Packing and Grading*

Nursery 1 is relatively so small, the packing shed is used for so many different purposes, and the glass-house work is so intermittent that a proper system of packing can scarcely be looked for. It possesses, however, one interesting feature—that the grading is done separately from the packing and carried out with the help of a mechanical device. In Nursery 2 the grading and packing are done simultaneously and much more roughly than in Nursery 1.

Throughout this investigation the writer has commonly found a good deal of what can only be called confusion in the packing of fruit. He is of course aware of a very different state of affairs at the large central packing stations in America and Australia and even in certain parts of England. But even in some of these there may still be room for the application of more scientific methods of management. The packing in Nursery 2, which is indicated in Fig. 6, is not without system, but it has many inherent defects. Some of these defects are no doubt the result of relatively small-scale operations ; but there seems to be real scope for considerable improvements even under present conditions of output.

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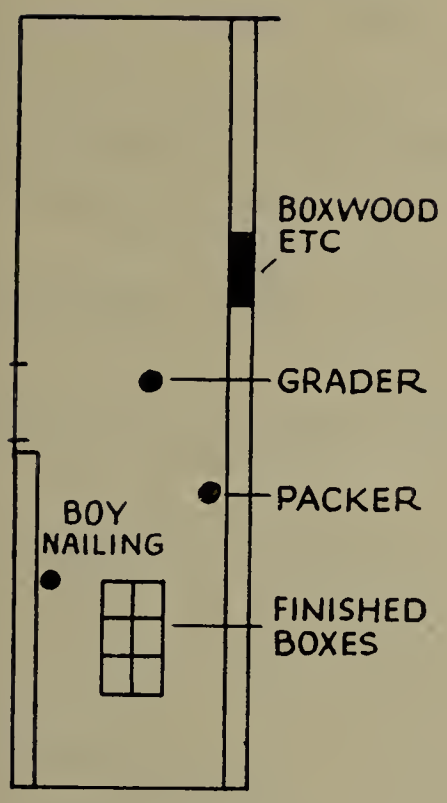
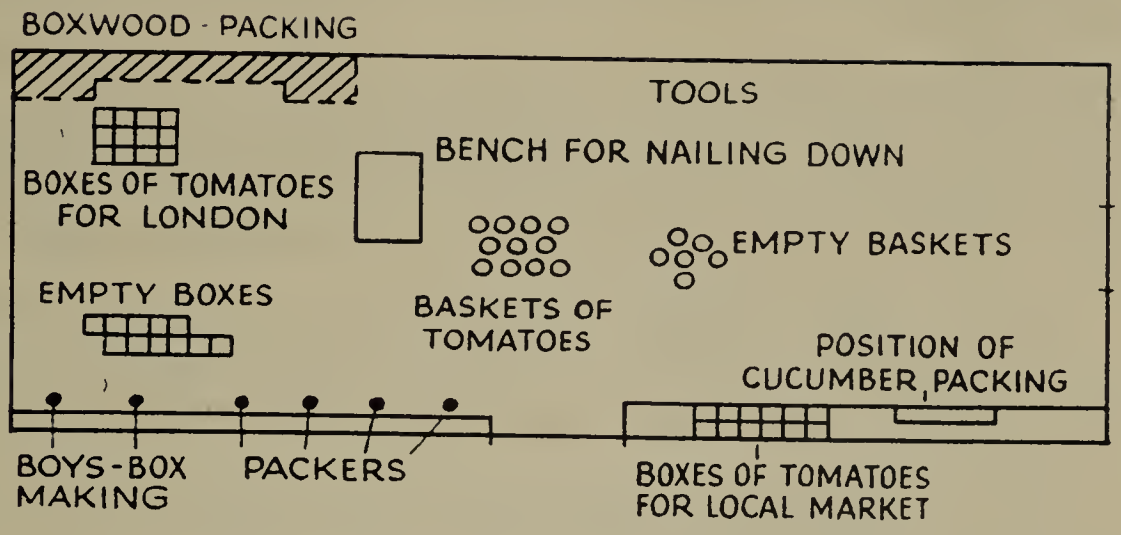
[1] From the standpoint of this investigation, it would have been more satisfactory if such changes could have been introduced while the inquiry was in progress. It would then have been possible to show in this Report by actual figures the advantages gained by the alterations.

FIG. 5



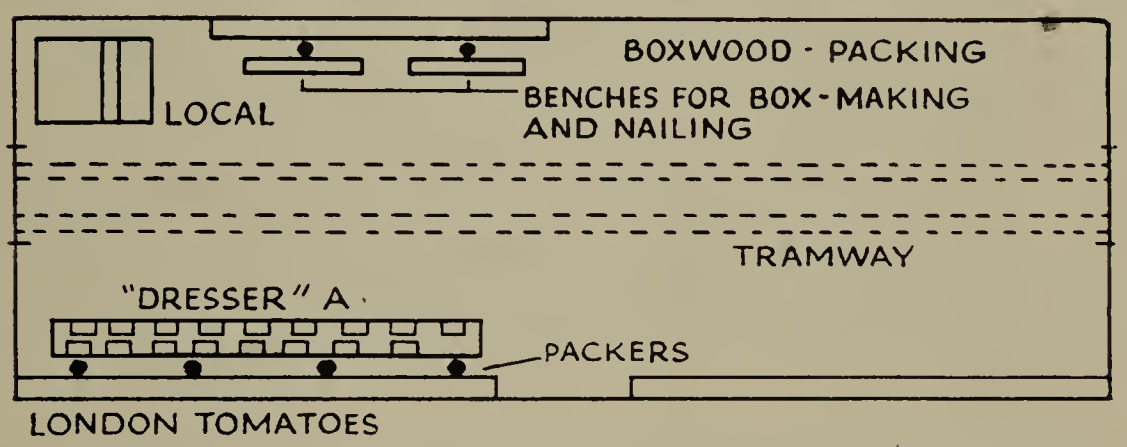
Packing shed of Nursery 1

FIG. 6



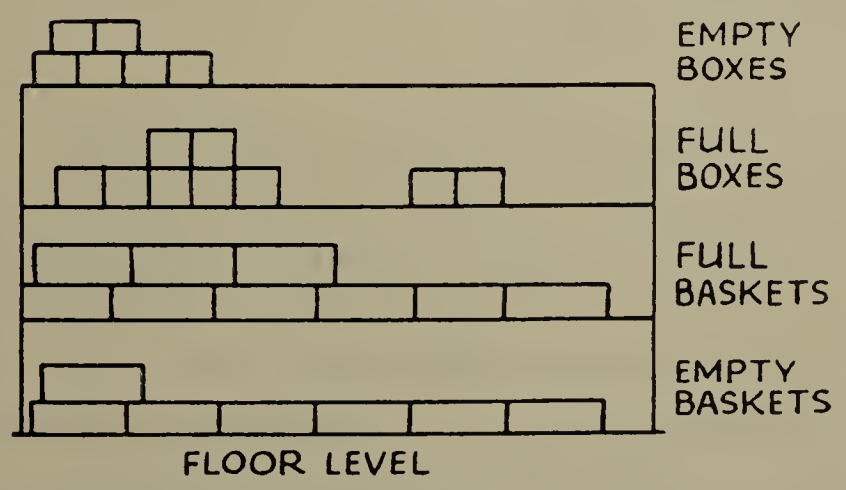
Packing shed of Nursery 2 (*present system*)

FIG. 7



Packing shed of Nursery 2 (*showing suggested reorganisation of work*)

FIG. 8



Elevation (enlarged scale) of Dresser shown at A in Fig. 7

Some of the defects indicated in the existing system, shown in Fig. 6, are as follows :

(*a*) Bad arrangement of material ;
(*b*) Consequent on (*a*), unnecessary amount of walking about ;
(*c*) Consequent on (*a*) and (*b*), defective flow of material ;
(*d*) Two boys hammering at the same bench at which the packers are working.

(*d*) is objectionable from two points of view—first, the hammering shakes the bench, and secondly, though it may not cause any conscious annoyance to the packers, it must have an unconscious effect on them of an injurious kind.

Fig. 7 shows the suggested rearrangement. It is an attempt to " departmentalise " the work :

(*a*) Box-making and nailing down and material needed are placed together at one side of the shed.
(*b*) The packing is done at the same bench as before, but behind the packers is a " dresser " (see Figs. 7 and 8) composed of three tiers or shelves to accommodate both the materials they need and the materials they have finished with. Empty boxes are removed by the nailer-down. The full baskets are brought in by the router, who also removes the empty baskets at the ground level. Thus the packers can proceed almost continuously with grading and packing, without moving from their positions.
(*c*) Boxes ready for despatch are all put together near the exit by the nailer-down.
(*d*) A narrow gauge tramway has been suggested for this nursery, and if it be constructed it would probably be useful to run a couple of lines straight through the packing shed as shown in Fig. 7.

It is, of course, impossible to predict the ultimate value of these suggestions without actual trial. The procedure would at first be strictly tentative, the suggestions being tested with makeshift arrangements in the first instance before making an outlay of capital.

6 *Methods of Packing and Grading*

In Nursery 1 (see Fig. 5) a woman does the grading by running the fruit one by one along a channel or grader containing different-sized holes through which they drop by gravity into compartments corresponding to the holes. The packer collects and packs these different grades (six altogether) in separate boxes, arranging the fruit according to a prescribed system with great accuracy and care. In Nursery 2 each person takes a basket of 12 lbs. of fruit, and with six boxes in front of him grades and packs simultaneously. The more careful packing and grading in Nursery 1 do not appear to result in a higher

price being paid per pound. Yet the real costs involved are vastly different, as the following figures show :

IN NURSERY 1

To grade 12 lbs. of small to " medium-sized " tomatoes takes				4 mins. 0 secs.
„ collect	„	„	„	0 „ 20 „
„ pack	„	„	„	5 „ 0 „
Total time for grading and packing - -				9 mins. 20 secs.

IN NURSERY 2

Time for grading and packing 12 lbs. of small to " medium-sized " tomatoes - 3 mins. 30 secs.

The time of the packer in Nursery 1 could be somewhat reduced : (*a*) by placing the grading machine near her and at bench level, instead of on the floor some yards away as it is at present ; (*b*) by using a lower bench with a sloping surface ; and (*c*) by using both hands in the process of packing.

The benches are also too high in Nursery 2. The packers have discovered this, using a wooden platform to stand on. They might advantageously use four wooden platforms of different heights, to suit each man respectively. Their benches also should have a sloping surface. One or two men are able to use both hands simultaneously, but not all the men can do this.

There are considerable individual differences in the rate of packing. The following is the result of a careful test at Nursery 2 with fruit of exactly the same run of size and total weight :

First Packer (12 lbs. fruit) - -	4 mins. 0 secs.
Second „ „ „ - -	3 „ 15 „

An interesting test was also made in Nursery 1 to ascertain the difference in rate between grading into four baskets (*a*) with the grader and (*b*) by hand and eye alone.

With the grader (12 lbs. tomatoes) - -	4 mins.
By hand and eye alone (12 lbs. tomatoes)	3 mins.

But in considering these figures, it must be remembered that the work of the grader is much more accurate and elaborate, and also that there is greater fatigue in grading by hand and eye. During this demonstration the strain of deciding what fruit to put in one basket or another was undoubtedly severe. It is true that the woman who was tested was out of practice, but she had nevertheless graded by hand and eye during the previous year.

7 *Light and Ventilation*

In Nursery 2 all the windows of the packing shed run along the packing bench shown. The windows have a southern exposure ; it is very hot and the light is very dazzling at the packing benches on a fine summer day. While good lighting is essential for packing it is generally recognised that diffused

light is better than direct sunlight. The building being of wood with a black roof, high temperatures are almost unavoidable. But in both packing sheds greater attention should be paid to ventilation. Experience during the present investigation indicates that neither foremen nor their men will trouble to open windows and doors, particularly the correct windows and door, so as to allow of proper air movement.

8 *Box-Making and Nailing Down.*

This work is done by boys, and a good deal of variation in rate of work is to be expected. The following timings were taken in the packing sheds of Nurseries 1 and 2 :

IN NURSERY II

One boy to make a tomato box complete takes -	2 mins. 13 secs.
One boy making bottom and another side complete takes - - - - - - - -	2 „
One smaller boy making complete box takes -	2 „

IN NURSERY I

One boy to make a box takes - - - -	4 mins.

9 *Unproductive Time*

In Nursery 1 the actual output of picked, graded and packed fruit during a certain period was compared, on two occasions, with the estimated output based on previously determined rates of working.

Case 1 (between 9 a.m. and noon). Picking proceeded with considerable interruptions between 9 a.m. and 11 a.m. Grading started at 9.48 a.m., and the whole job was completed (except for nailing down) at 11.45 a.m.

(*a*) 9 boxes (of 17 lbs. each) were picked and carried out to the packing shed. (*b*) These were finally graded and packed into $4\frac{1}{2}$ boxes of 12 lbs. each (closely packed) and 5 boxes of 12 lbs. each (loosely packed). There was a bushel of " smalls "—a by-product of the grading.

On (*a*) the time actually spent was 2 hours 36 minutes. On (*b*) the time actually spent was 2 hours 2 minutes.

The following is a generous estimate of the time that *should* have been needed:

To pick a 17-lb. box with a good run of fruit does not take a fair picker longer than 7 minutes ; with a thin run of fruit not longer than 12 minutes. The run on the present occasion was fairly thin, so the latter figure must be used. Hence the estimated time required is 1 hour 48 minutes.

Estimated time required - -	1 hr. 48 mins.
Add 9 minutes for moving boxes -	9 „
Total time needed for picking -	1 hr. 57 mins.

or 39 minutes less than the time actually taken.

Let us now follow up the grading and packing of this picked fruit. To grade a box of 17 lbs. does not take longer than 7 minutes. Hence the estimated time required for grading is 1 hour 3 minutes. Packing *loose* takes 2 minutes per box of 12 lbs. Packing *close* takes 5 minutes per box of 12 lbs.

Hence the estimated time for packing is -	33 mins.
Add 10 minutes for collecting, etc. - -	10 „
Total	43 mins.

That is to say, the total time needed for grading and packing is 1 hour 46 minutes, or 16 minutes less than the time actually taken.

Thus of the 4 hours 38 minutes expended on the entire job, 55 minutes (*i.e.* about 20 per cent.) was in excess of the estimate based on previously ascertained rates of picking, grading and packing.

In considering the reasons for this, it must be clearly understood that the 4 hours 38 minutes was the time actually spent on the job : the time absent through interruptions is not included.

The chief reasons for the loss were as follows :

(*a*) One picker was interrupted at 9.17 a.m., and again at 10.25 a.m. to sell vegetables to retail customers ;
(*b*) Another picker was interrupted for the same purpose at 10.30 a.m. (the rates were reduced principally by the mental effects of the interruptions) ;
(*c*) One of the pickers was entirely unskilled and therefore exceedingly slow ;
(*d*) The grading was held up for 5 minutes for want of supply of fruit ;
(*e*) After actually finishing the job, the packer spent 10 minutes in walking round the sheds to see what there was to do next, and eventually went home at 11.45 a.m., instead of at 12 noon.

It may be noted that since the retailing was done at wholesale prices, the Nursery derived no return for its services and actually suffered a real loss of at least 20 minutes on picking and nearly an hour of other time.

Case 2. This is similar to the above and may be reproduced more briefly. On a certain day there was an output of 44 boxes of packed tomatoes.

2 pickers	were at the job	5	hrs.	between them in the morning.	
1 packer	was „ „	$5\frac{1}{4}$	„	(10 a.m. to 4.15 p.m.)	
1 grader	„ „ „	$4\frac{1}{2}$	„	(10 a.m. to 3.30 p.m.)	
1 nailer	„ „ „	3	„	(1 p.m. to 4 p.m.)	

On the basis of time studies :

2 pickers	together should have taken only	4 hrs.	21 mins.
1 packer	„ „	4 „	43 „
1 grader	„ „	3 „	18 „
1 nailer	„ „	2 „	3 „

Thus there appears to have been 3 hours 50 minutes of excessive time. The reasons are as follows :

(*a*) The woman grading was standing about doing nothing for 45 minutes because she finished grading before the packer ; she was also kept waiting for a fresh supply of fruit from the glass-house ; she was eventually told she could go home at 3.30 p.m.
(*b*) Several interruptions occurred in the glass-house during the morning.

The two cases just described are not strictly representative of ordinary commercial conditions. At the same time, a great deal of the unproductive time shown to exist is not by any means unavoidable. In addition to the reduction of unproductive time, it is believed that the productivity of productive time could be increased by changes of system and methods of work. Indications of these changes were given in discussing the routing and packing in Nursery 2.

II MILKING

[A] INTRODUCTION

1 *Complexity*

The processes and the general situation involved in the milking of cows are very much more complex and delicate than those involved in such work as fruit-picking and -packing. A more technical approach becomes necessary and consequently in this part of the Report purely practical information must be supplemented by a certain amount of theory and technical detail.

To make the situation in milking clear, it may be recalled that in discussing fruit-picking and -packing our attention was mainly centered on the worker. Although the plant and the material which the worker principally handled was living material with all the variability and perishability that characterise it, the plant and material were nevertheless inert. But in the process of milking we are faced with a situation which involves a complex relation and adjustment between a man and a farm animal both of which are capable of delicate neuro-muscular responses, while the material—the milk—is a physiological secretion intimately dependent on nervous reactions to stimuli. In addition, the situation is rendered still more complex psychologically by the special and peculiar responsibilities which devolve on a conscientious milker, especially in relation to his employer.

2 *Constitution and Environment*

The essential point, then, is that in milking we have to consider both the milker and the cow. Each possesses individuality, each is influenced by environment, and each is influenced by the other, and also, it may be added, by the owner.

The biological situation may be indicated thus :

Cow	⇅	Constitution Environment
Milker		Constitution Environment

the environment being, to a large extent, common to both.

Now with regard to the two essential characters with which we are concerned, namely, yield of milk in the cow and milking capacity in both cow and man, we have—

(*a*) In the cow
individual differences between different cows ;
variations day by day in the same cow.

(*b*) In the milker, similarly
individual differences between different milkers ;
variations day by day in the same milker.

According to Gowen, " roughly about one-half of the variation (measured by the coefficients of variation) in milk production results from the varying

genotypic individuality of the animal with respect to this character, and the other half results from the varying external circumstances to which cows are subjected during lactation and which have an effect on the flow of milk ; or put in another way, if a large number of cows were placed in environmental circumstances which were at once ideal and uniform we should expect the variation exhibited in milk production to be roughly about one-half of that which we actually find when we measure the variation under ordinary circumstances."[1]

The relative importance of "constitution" and environment as regards variation in the milker has not been studied, but some of the information collected in the present investigation throws a little preliminary light on this point, at least indirectly.

[B] THE PROCESS OF MILKING

1 *The Secretion of Milk*

The secretion of milk is involuntary, and it may be considered as taking place in two more or less distinct phases—(*a*) during the process of milking, and (*b*) during the intervening period of rest ; the duration of the former being from 5 to 15 minutes, and the duration of the latter varying from 5 to 15 hours according to the system of milking employed. Over two-thirds of a cow's yield of milk is produced during the milking period, when, by reflex action in response to the stimulus of massage, the spherical epithelial cells of the milk vesicles continuously pour milk into the lactiferous ducts which convey it to the milk cistern immediately above each teat. Towards the end of this milking phase the cells are believed to become ruptured ; they certainly discharge a large proportion of butter fat which makes careful "finishing" exceedingly important. During the rest period the epithelial tissue is repaired, but milk secretion still continues slowly and, according to Zeitzschmann,[2] starts again soon after the cow is "finished." At any rate the milk cistern is full by the next milking-time.

2 *The Process of Milking*

Milk can be drawn from the cistern through the channel of the teat by various means—by the calf itself, by the hand of man, or by machinery, all of which depend on the creation of a vacuum in the channel of the teat. According to Zeitzschmann, the milk is also partly forced into the teats by muscular contraction in the udder, induced by sucking or manipulation. In a normal cow the milk cannot escape without appropriate stimulation, on account of the ring of yellow elastic fibres which causes a constriction near the teat's tip. In

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[1] *Cf.* W. Gowen, *Milk Secretion*, 1924.

[2] O. Zeitzschmann, *Deutsche tierärztliche Wochenschrift*, abstracted in the *Experiment Station Record*, vol. 49, 1923, p. 17.

the process of milking by hand, the milk can be drawn by placing the thumb and first finger on either side of the top of the teat, well up against the udder, and drawing downwards ; or else by grasping the teat with the whole hand, and applying a rhythmical downward wave of pressure with the four fingers. (In rapid motion there is usually a certain amount of " pulling " and " bumping " of the hands against the udder ; if at all excessive, this is bad and indicates unskilful milking.) The former method is known as " stripping " and is only resorted to when the second or " full-handed " method is impracticable on account of an inadequate flow of milk. It will be evident that the process of milking by hand makes considerable demands upon the muscles of the fingers and arm. But it seems that after a few months' practice milkers get accustomed to the work, and in the present investigation physical fatigue in hands and arms was not complained of, except after the completion of an unusually large task. The movements of the milker during the milking process will be considered in greater detail later (page 57) under the heading of " skill."

3 *Machine Milking*

The question will arise as to why milking by hand is still generally practised. Modern milking machines perform the process effectively, though it is perhaps doubtful whether they can always be relied upon to strip the cow to the end—an exceedingly important matter. There are several objections to the employment of milking machines. One is that machine milking always spoils certain cows. In England cows are relatively expensive and labour relatively cheap ; one objection to machine milking, therefore, is that it is not economic. Another objection is the difficulty and labour involved in keeping the attachments and indeed the whole machine sterile. An extensive survey of the use of milking machines in the State of New York a few years ago resulted in the conclusion that the use of milking machines is entirely out of the question on the average farm. For the milk to be kept reasonably clean it is essential that the attachments be sterilised each time they are used ; and this is generally impossible on the ordinary farm. It would be interesting, however, to see carefully compiled comparative costings and to investigate the methods on the Continent and in Australia and New Zealand where milking machines are commonly employed. The fact remains that mechanical milking is not general in England and America. Apart from injury to expensive cows, the fact that it does not pay if there are less than 30 cows no doubt has a great deal to do with this in England. The possibility of mechanical breakdowns is also a factor.

[C] THE RATE OF MILKING

1 *Practical Importance*

In the cowshed, as is well known, the actual process of milking constitutes only a part of what in practice is regarded as the whole operation of milking.

But it is the most important part (as will be shown later), and it is obviously the process and situation to concentrate on first because of its " centrality " and its fundamental productiveness. From the standpoint of Industrial Psychology our objective, here as in other processes, is to make the milking process easier for the worker (incidentally also for the cow) and, if possible, to reduce the economic cost. But, as we have already mentioned, milking is not usually very fatiguing physically to those who are in practice and carry out the process properly. The principal real cost to the milker is the time he spends on the process. Provided that there is no great increase in *physical* fatigue, an increase in the rate of milking should be in the interests of both worker and employer. And since, where a great deal of milking has to be done per man, it is monotony or *mental* fatigue that is complained of, any reasonable degree of speeding-up would seem to be clearly advantageous.

In addition, there seems to be good evidence that most cows prefer to be milked rapidly, and it is also stated that quick milking tends to increase the butter-fat content of the milk. By fast milking is meant smooth thorough milking with a steady and as full a flow as possible : any endeavour to " rush " the process is not fast milking, although it might appear to be so superficially. It is misdirected energy and harmful.

The question will sooner or later arise as to what order of saving might be expected from increasing the rate of milking, and the point may be considered at once. Assume, as quite commonly occurs, that a milker is actually milking 3 hours per day and that his mean rate is 1 lb. of milk per minute. If his mean rate could be increased to 1 · 5 lbs. per minute, he would get the same output in 2 hours. If his mean rate could be increased to only 1 · 2 lbs. per minute, there would be a saving of 30 minutes.

The present investigation indicates that this latter increase is certainly within the bounds of possibility. But it is sometimes argued that such a saving would be of little value, because as the worker is on day-rate he has to be doing something and might just as well be milking, and because as the agricultural worker's hour costs only eightpence, thirty minutes or fourpence is not worth troubling about.

This narrow, apathetic outlook must be overcome. There can be no doubt that the rate of milking well deserves the closest attention. It is evidently influenced by a large number of factors, and statistical investigation shows that it is subject to very great variation. It seemed that the best scientific approach in this inquiry towards the problem of increasing the rate of milking would be to study the variation in relation to various factors, including not only the factors of environment, but also the relevant constitutional factors among cows and milkers respectively.

Probably the chief objection which will be advanced to the work which has been here attempted in this direction and is now about to be described will relate to its paucity. But it must be remembered that the entire investigation

comprised in this Report was compressed into a period of three months, and that less than one-third of this time could be devoted to the study of milking. Moreover, appropriate methods had to be devised and tactful caution was needed in introducing an investigation strange to agriculture. If, therefore, the statistical evidence brought forward is limited in quantity, it deserves, nevertheless, to be regarded as a serious contribution to a preliminary study of the subject.

2 *Timings and Extent of Variation*

Most of the statistical data were obtained from measurements made on three milkers and sixteen cows over a period of twenty days at the Wye College Farm. On special points other milkers and other cows were also studied. Without the practical assistance of the Wye milkers themselves the data could not have been secured ; for each milker had to be timed every night and morning at every cow he milked, and these figures (together, of course, with the weight of milk and the milker's name) and sometimes other points had to be systematically recorded. After preliminary training the milkers, who were ordinary workers on the usual weekly wage, carried out practically all the timing and recording themselves. Each milker worked with a stop-watch in his pocket tied with string to a button-hole. Occasional checks proved that they carried out the timing conscientiously and accurately. The investigator wishes to record his appreciation of this co-operation ; for although he was present on most occasions, other matters had to be attended to and in any case there would have been great difficulty in working single-handed with three stop-watches. Altogether 435 timings were made.

In Table 6 are shown the mean daily rates, morning and afternoon, for each of three milkers at Wye College Farm. Apart from one or two exceptional cases, the variability of any one milker is not great ; that is to say, it is seldom more than 10 per cent. of his average, and usually less. It will be noticed also that the *inter-periodic* means vary scarcely at all.[1] Evidently the means for the entire period (1–20) are fairly representative of the rates of these milkers—at least during the summer months.

But when we come to examine a milker's rate for different cows, the variation is found to be exceedingly great. He may milk one cow on the same afternoon at the rate of 2·5 lbs. per minute, and another at the rate of only 0·5 lbs. per minute. This can only mean that the cow is an important factor determining the variation of the rate of any one milker. It seemed desirable, therefore, to investigate this point.

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1 These "inter-periodic means" are the milkers' mean rates of milking over two shorter periods within the whole period of 20 days : the first period comprises the first ten and the last four days ; the second, the remaining six days.

TABLE 6

Showing the Mean Daily Rates of Milking in Pounds per Minute for Three Milkers at Wye College Farm ; also their Mean Rates over a Period of Several Days (August 1926).

Days (Consecutive)	Morning (6–8)						Max. Temp. F.	Relative Humidity at 4 p.m.	Afternoon (3–5)					
	Milker A		Milker B		Milker C				Milker A		Milker B		Milker C	
1	—		—		—		—	—	1·3		1·2		—	
2	—		—		—		—	—	1·4		1·1		0·9	
3	1·4		—		—		68	53	0·9		1·1		—	
4	1·6	mean	1·7	mean	1·3	mean	69	75	1·4	mean	1·1	mean	—	
5	1·2	of 1	1·4	of 1	1·0	of 1	65	61	1·3	of 1	1·0	of 1	—	
6	1·5	to 10	1·1	to 10	1·2	to 10	71	80	1·3	to 10	1·0	to 10	—	0·9
7	1·5	plus	1·1	plus	1·0	plus	68	82	0·9	plus	—	plus	0·9	
8	1·3	17 to	1·2	17 to	1·1	17 to	71	45	1·5	17 to	—	17 to	0·9	
9	1·4	20 =	1·1	20 =	0·9	20 =	68	79	1·3	20 =	1·2	20 =	—	
10	1·4	1·4	1·3	1·25	1·0	1·0	74	60	1·4	1·24	1·1	1·07	—	
11	1·6		1·2		0·9		77	65	1·3		1·0		—	
12	1·4		1·2		0·7		77	61	1·3		0·9		—	
13	1·5		1·2		1·0		69	99	1·2		—		0·9	
14	1·4	1·4	1·1	1·2	0·9	0·9	68	71	—	1·26	0·8	0·96	1·0	0·93
15	1·2		1·1		1·0		66	81	1·3		1·0		—	
16	1·4		1·2		0·9		67	95	1·2		1·1		0·9	
17	1·3		1·3		0·8		70	49	1·0		0·9		—	
18	1·4		1·1		0·9		71	66	1·2		1·0		—	
19	1·4		1·2		—		—	—	1·1		1·0		—	
20	—		—		—		—	—	1·3		1·1		—	
Mean for whole period (1 to 20)	A 1·4		B 1·2		C 1·0				A 1·25		B 1·0		C 0·9	

Note.—All these values are the *means* of the milking rates for 5 or more cows on each respective morning or afternoon. Since each milker had some easy and some hard cows, variation caused by the individual cow was thereby largely eliminated. The lowness of the mean rates of these milkers is due mainly to the " hardness " of the herd.

[D] INDIVIDUAL DIFFERENCES IN COWS AND THEIR INFLUENCE

1 *Yield of Milk*

Let us now consider two cows, similar in other respects, but differing greatly in their milk yield. The question arises—will one and the same milker tend to milk the heavy-yielding cow at a faster rate than he will milk the poor-yielding cow ? Dot charts were constructed in which yield was plotted against rate. These indicated a certain positive correlation ; but it was found that unless great care was taken to select cows " similar in other

respects"—not an easy matter, there were clear indications that other and more important factors than yield were responsible for the big variations in rate.

2 *The "Holding" of Milk*

One of these factors is the phenomenon known as "holding." Where this occurs, the milker, during the process of milking, has periodically to change from "full-handed" to "stripping" because the cow periodically reduces the rate of flow of the milk and may even yield none at all for a few seconds, after which the flow will begin again. In its pronounced form, "holding" may apparently be constitutional. In support of this view, the behaviour of a Shorthorn aged 3 (1 calf) may be cited. A time analysis of one milking of this cow was carried out in order to provide information, if possible, as to the extent to which "holding" and consequent stripping and waiting reduce the milker's rate.

The following results were obtained :

Method of Milking	Time Taken	Yield of Milk in lbs.	Rate of Milking lbs. per min.
Full-handed	0′ 30″	1·25	2·50
Stripping	0′ 15″	0·25	0·50
Full-handed	1′ 37″	3·00	1·86
Stripping	0′ 12″	0·25	1·25
Full-handed	1′ 5″	0·75	0·69
Stripping	1′ 30″	1·00	0·66

In the normal cow, stripping is not necessary until towards the end of milking. Altogether, this cow gave $6\frac{1}{2}$ lbs. in 5 minutes 9 seconds, or 1 · 3 lbs. per minute (average rate). But it will be noticed that the average rate during the stripping was less than half of that during full-handed milking. The progressive decline in the rates during the course of the whole process may be due to the fatigue of the milker ; but it is more likely to be natural to the cow, though perhaps accentuated by the interruptions and even by the experiment itself. The essential point is that there is no doubt that "holding" can be responsible for reducing a milker's rate by at least one-half.

"Holding" has been given some attention by Zeitzschmann.[1] He considers it to be caused by nervousness or strange conditions, or by pain in one or more teats. In his opinion involuntary excitement of the muscles of the teats occurs, and this, acting on the sympathetic nervous system, reacts detrimentally on the process of secretion. Zeitzschmann seems to imply that it is produced by environmental and physiological influences. The writer's experience, though admittedly limited, indicates that "holding" can be constitutional and therefore unalterable.

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[1] O. Zietzschmann, *Deutsche tierärztliche Wochenschrift*, abstracted in the *Experiment Station Record*, vol. 49, 1923, p. 173.

3 "*Hardness*"

A factor of much greater influence on the rate of milking is "hardness." When an experienced milker calls a cow "hard," he means that he has to work hard to get the milk out of her udder. Cows which "hold" are not necessarily "hard." Very often they are "easy." The cow now under consideration was quite easy to milk—when the milk was there. Hence her milker attains the quite good average rate of 1·3 lbs. per minute.

Other observations during the course of this investigation suggested that a thin stream of milk is common to "hard" cows. It may therefore well be that one cause of "hardness" is the narrowness of the diameter of the teat channels. Indeed this seems to be generally accepted as a cause, and the passage of catheters has been tried but apparently without much success. "Hardness," whatever its physical explanation, is congenital. The size and shape of the teat are also probably factors, although a cow with defects in this respect is usually referred to by milkers as "awkward" rather than "hard."

The conformity of judgment of milkers as regards "hardness" is shown in Tables 7 and 8.

TABLE 7

HERD 1. (MEN MILKERS)

Name of Cow	Breed	Yield [1]	Age in Years	Number of Calves	Milkers' Judgment of Cows [2]			Temper	Remarks
					Milker A	Milker B	Milker C		
Barbara	Shorthorn	Hv	10	8	E	E	M	Good	Fidgets
Jessie	,,	Hv	8	5	M	M	M	Good	Sluggish
Maggie	,,	Hv	8	5	E	M	E	Bad	
Katie	,,	Hv	9	6	E	E	E	Good	
Tibbie	,,	M	9	6	E	M	M	Good	
Rose	,,	Hv	8	6	M	H	M	Fair	
Doris	,,	M	8	6	E	M	E	Melancholy	Holds her milk
Jocelyn	,,	M	3	1	E	E	E	Good	
Amy	,,	M	4	2	E	E	E	Good	
Lucy	,,	M	—	—	M	E	M	Good	
Princess	,,	M	4	2	M	H	H	Good	
Polly	,,	Hv	4	2	M	M	H	Vicious	Kicks
Beauty	,,	M	4	2	E	M	M	"Funny"	
Ivy	,,	M	4	2	E	E	E	Good	
Dolly	,,	—	—	—	H	H	H	Bad	
Norah	,,	M	—	—	M	E	E	Good	
Sybil	,,	—	3	1	M	E	M	Good	
Kathleen	,,	Hv	3	1	M	E	M	Good	
Peggie II	,,	M	3	1	H	M	H	Fair	
Ruth	,,	M	3	1	E	E	E	Lively	
Jane	,,	M	3	1	E	E	E	Good	
Phoebe	,,	P	3	1	E	M	E	Bad	Fidgets and holds milk
Nellie	,,	M	3	1	H	H	H	Vicious	Kicks

[1] Heavy (Hv). Medium (M). Poor Yielders (P).
[2] Hard (H). Medium (M). Easy (E).

TABLE 8

HERD 2. (WOMEN MILKERS)

Name of Cow	Breed	Yield [1]	Age in Years	Number of Calves	Milkers' Judgment of Cows [2]			Temper	Remarks
					Milker A	Milker B	Milker C		
Snowball's Pet	Jersey	M	14	8	E	M	E	Good	Holds her milk
Agatha	,,	M	6	3	E	E	M	Good	
Daws Bell	,,	P	5	2	E	E	—	Good	
Beacons-field	Cross-bred	Hv	6	4	H	M	—	Good	
Judy	,,	M	3	1	M	M	M	Good	
Nigger	,,	Hv	4	2	H	H	H	Good	
Bessie	,,	Hv	4	2	E	E	—	Good	
Nora	Guernsey	Hv	8	5	E	E	M	Bad	
Rose	,,	Hv	8	5	E	E	E	Good	
Deodora	,,	M	5	4	M	M	M	Good	
Gleam	,,	Hv	9	6	E	E	E	Good	Holds milk
Daphine	,,	Hv	9	6	E	E	E	Good	
Boughton	Shorthorn	Hv	7	5	E	E	E	Good	
Lemon	,,	Hv	5	3	E	M	—	Fair	Nervous
Beauty	,,	Hv	5	3	H	H	H	Vicious	Kicks
Smuts	,,	M	5	3	M	E	—	Good	
Buttercup	,,	M	5	3	M	M	—	Good	
Princess	,,	M	8	6	E	E	E	Good	
Thimbletry	,,	M	8	6	E	M	—	Fair	
Cowslip	,,	?	5	3	E	M	E	Good	
Pride	,,	?	3	1	M	M	M	Good	
Cherrystone	,,	P	2	1	M	M	E	Bad	
Fulford	,,	Hv	5	2	M	M	M	Bad	

[1] Heavy (Hv.) Medium (M). Poor Yielders (P).
[2] Hard (H). Medium (M). Easy (E).

Note.—Herd 1 is younger than Herd 2, and therefore, on the whole, rather harder to milk and manage. It will be observed that all milkers on the same cows are substantially in agreement as to which cows are distinctly " hard " and which are distinctly " easy " ; their opinions were taken quite independently.

The following figures (Table 9) show the close correspondence between milking rate and " hardness."

TABLE 9

Name of Cow	Description [1]	Mean of 10 afternoon rates :	
		Milker A	Milker B
Nellie	Very hard	0·7 lb. per min.	0·6 lb. per min.
Princess	Hard	0·7 lb. per min.	0·6 lb. per min.
Peggy II	Hard	1·2 lbs. per min.	0·6 lb. per min.
Amy	Very easy	1·8 lbs. per min.	1·3 lbs. per min.
Ivy	Very easy	1·7 lbs. per min.	1·5 lbs. per min.
Barbara	Easy [2]	2·0 lbs. per min.	1·4 lbs. per min.

[1] Based on independent opinions of 3 milkers which agreed, and on personal trial.
[2] It will be noted in Table 7 that Milker C judged this cow as " medium." Subsequent evidence indicated that this judgment was inaccurate, the cow under consideration being certainly easy.

These data suggest that " hardness " is one of the principal factors, if not *the* principal factor, influencing variability in the rate of milking.

4 *Temperament*

Some cows are constitutionally bad-tempered. In this investigation many of the " hard " cows were bad-tempered, but it does not follow that a bad-tempered cow is always " hard," at least not in the specific sense in which that term has been used. Bad-tempered cows are hard in that they try the patience and often cause delay. This is especially true of " kickers." The ultimate economic effect is a reduction in the rate of milking. Kicking can be and is prevented by various devices ; but the carrying out of these devices takes time, which increases the cost of the total milking operation.

5 *The Physiological Factor*

Individual differences among cows, so far considered, have been of a constitutional nature. We have to consider now temporary differences which are produced by physiological changes and by environment.

(*a*) Lactation Period.—This is responsible for seasonal variations in yield and must therefore have an effect on the rate of milking. Cows are easier to milk after calving and " harder " to milk as they gradually go " dry."

(*b*) Age.—The yield varies with age. The age of maximum yield is about 8 years. Young cows (heifers) are usually harder to milk than older cows.

(*c*) Feeding.—The yield depends on feeding ; although scientific rationing has reduced variation from this cause, yield is usually greater in summer than in winter. Stall-feeding during the process of milking tends to reduce the rate of milking, since it makes the cows fidgety, thereby disturbing the milker.

(*d*) Weather.—Cows are usually more fidgety in hot weather, and when flies are abundant. This is an important factor affecting the rate of milking.

(*e*) Strange Conditions.—Cows are curiously sensitive to strange surroundings. A sudden change from one side of the cow shed to the other, for example, will produce a disturbing effect ; but the animals soon adjust themselves to the new conditions, provided that they are not physiologically unfavourable.

(*f*) Response to Milker.—A cow appears to prefer being milked by the same person ; but experiments in America indicate that " a change from a poor to a *good* milker, even though the good milker be a stranger, showed an immediate increase in milk yield." [1]

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[1] F. B. Linfield, *Experiment Station Record*, vol. xii, p. 782.

[E] INDIVIDUAL DIFFERENCES IN MILKERS

1 *Indicated by Mean Rate*

The means given in Table 6 for the rates of milking at Wye College Farm clearly indicate constant individual differences. In Table 10 these are shown together with particulars as to sex and age. The rates, etc., of four other milkers on other herds are also given, but caution must be exercised in instituting comparisons. A, B and C are strictly comparable among themselves, also D, E and F ; but the groups (A, B and C), (D, E and F) and (G) are not strictly comparable with one another, on account of differences in the herds. Their past experience varied with their age.

TABLE 10

Milker	Sex	Age	Mean Rate of Milking in lbs. per min. Morning	Afternoon
A	Male	33	1·4	1·25
B	Male	22	1·2	1·0
C	Male	18	1·0	0·9
D	Female	35	—	1·4
E	Female	28	—	1·2
F	Female	25	—	1·2
G	Male	40	—	1·8

Additional evidence indicates beyond doubt that the first milker in any group is faster than the second and third in any other group. The mean rates of A, B and C are based upon a much larger number of observations than those of D, E, F and G, and in the case of A, B and C we are able to compare one milker with another *on the same cow at the same time of day.*

The following figures for afternoon milking are of interest :

Cow	Mean Rate of Milking in lbs. per min. Milker A	Milker B	Milker C
Ivy	1·7	1·5	1·3
Phoebe	1·2	0·8	0·9
Polly	1·3	1·2	—
Nellie	0·7	0·6	—

They furnish convincing evidence of the extent of individual differences.

2 *Age and Sex*

There appears to be a correlation between rate of milking and the age of the milker ; but the number of observations is, of course, very small. Definite information is not available to show whether this apparent connection is due mainly to greater skill resulting from experience and training or is mainly due to the responsibility and greater physical strength of mature age. Both must

operate to some extent. Some light is thrown on this point by the ratings to be given later on. As regards sex differences, it is fairly clear that female milkers can be at least as good as male milkers ; indeed other evidence is available to show that they are often better.

3 *Morning and Afternoon Rates*

It was not possible to take morning rates for milkers D, E, F, G ; but as regards A, B and C, the difference between morning and afternoon milking is definite. The causes appear to be (*a*) greater pressure of time in the morning, (*b*) freedom from fatigue, (*c*) lower temperature, absence of flies, etc., (*d*) heavier flow of milk.

4 *Qualities of Milkers*

So far, the differences as shown by performances have been considered. It is now necessary to go further and to inquire into inherent differences of a personal kind. Observation indicated that at least nine important temperamental traits are needed in a milker. The list of traits, which is given in

TABLE II

Trait	Weight of Trait	Milker : A	B	C	D	E	F
Conscientious	15	a	b	b	a	a	a
Patient	12	d	c	b	a	a	a
Persevering	7	a	a	b	a	a	b
Determined (masterful)	7	a	b	c	a	a	c
Attentive	7	a	c	b	a	a	a
Steady (when at work)	7	a	b	d	a	b	a
Punctual	6	a	d	c	a	a	a
Cheerful	4	b	b	a	a	a	b
Talkative	2	c	c	b	b	b	b
Love of Work	13	c	d	c	b	a	b
General Intelligence	20	a	d	c	b	a	c
	100						

A, B, and C are males ; D, E, and F are females.
a, b, c, d refer to decreasing degrees of the strength of the trait.

Table II, was submitted to the independent judgment of three persons in charge of milkers and was approved by them. With their assistance each trait was weighted with marks according to its importance, with results as shown. In addition to temperamental traits, a certain degree of general intelligence is also essential ; so also is "love of work" ; these were, therefore, also included. The six milkers were rated by the investigator only ; hence the rating is not free from risk. But in most cases the differences were so apparent as to make it unlikely that the investigator's estimates are incorrect. It will be noticed that the female milkers, D, E and F, score higher grades, as a whole, than the

male milkers A, B and C. The following is a brief verbal estimate of each person as a milker :

Milker A: Possesses in a high degree all the qualities needed but is deficient in patience.

Milker B: Only moderate as regards patience and attentiveness ; deficient in general intelligence and punctuality. Nevertheless a good reliable milker.

Milker C: More patient than A and B but somewhat variable. Youth is a factor in this case. Has the makings of a very good milker.

Milker D: This subject is a French woman. Possesses in a high degree all the qualities of a first-class milker. Rather excitable, but not impatient.

Milker E: Possesses in a high degree all the qualities of a first-class milker, but has a tendency to be unsteady (over-enthusiastic) when at work. This subject is definitely in love with her work.

Milker F: Possesses in a high degree the more important qualities but is rather weak (unmasterful) and not very intelligent.

It will be noticed that in general the female milkers are more patient and more talkative than the male milkers. All the milkers studied were cheerful : though only weighted with the mark of 4, this trait is not to be left out of account. It should be mentioned that all the female milkers were physically strong.

The results of the above analysis are in fair agreement with the milking rates already discussed.

5 *Skill*

Under " skill " we shall consider merely the actual manual process of milking. Differences exist which are evidently due (*a*) to constitutional causes and (*b*) to training and experience. To show these differences exactly, cinematograph films would be necessary. For present purposes a brief verbal description must suffice. From the point of view of economy of movement combined with a fair rate of movement, Milker F's performance deserves attention. In milking most cows her arms showed no lateral or vertical movements. Her movements were confined to the fingers, and the transmission of power was very much like that in the milking machine. It is scarcely an exaggeration to say that this transmission of human energy was beautiful to watch : the forearm kept perfectly still with just the ripple of the moving tendons to be seen below the flexor surface. In the case of Milker C, on the contrary, there was a large amount of vertical motion, and a certain amount of " pulling " at the teat as well as the rhythmic wave-movement of the fingers ; there was also even some lateral movement. In Milker F only the muscles below the elbow which move the fingers were brought into play ; whereas in Milker C the biceps and the pectoral muscles were utilised in

addition. Needless effort must have been involved in the second method, for the fingers had to do the same work in either case.[1]

It would seem fairly certain that the strength, softness and dexterity of the fingers must be factors in constitutional skill. Milker's "cramp" usually occurs across the back of the hand. This is evidently due to the straining of the tendons of the fingers. It is said usually to occur among milkers who squeeze the teat with all four fingers at a time. Good milkers feel fatigue principally in the wrist and forearm; and this is anatomically to be expected for the reasons stated above.

Training must also be important; it is of interest to record that Milker F had been definitely trained to milk, whereas most of the other milkers had merely learnt by crude experience.

6 *Treatment of the Cow*

The manner in which milkers talk to and handle cows is extremely important. In this investigation the women's method, while milking, was much superior to that of the men. The women spoke to them more often than the men and spoke much more *sharply* when they were troublesome. It sounded as if they were speaking to very naughty children.

7 *Variation in the Individual Milker*

If the performance of any one milker on one and the same cow be studied day by day (a.m. or p.m.), very considerable variation is found to exist. The rates and yields in respect of twelve cases are shown in the accompanying charts (Figs. 9–12). It will be seen at once that the percentage variation in the rates is much greater than the percentage variation in the yield.

One of the milkers, on being shown the chart of rates, said that the variation must be due to a falling off in yield, for (said the milker) when a cow starts to "go down" more time is spent at it to "coax out" as much milk as possible. This explanation is no doubt to some extent true, but it does not fit the data obtained in the present investigation. For in most of the graphs shown variations in rate occur quite independently of variation in yield, and there are several cases where a downward trend occurs in the rate with a practically constant yield.

It is difficult to find the exact causes of this variation, but it seems likely that there are two principal factors—(*a*) conditions of weather, and (*b*) psychological conditions. In the general table of milking rates (see p. 50) there does not appear to be any definite connection between the maximum temperature or afternoon humidity and the afternoon mean rate of milking.

In one or two cases (*e.g.* Milker A and the cow Amy) most of the rates

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[1] It is said, however, that a certain amount of "pulling" and "bumping" is necessary with certain udders common to certain breeds of cattle, particularly Shorthorns. This point has not been studied.

FIGS. 9–12

[Graphs showing individual milking rates (continuous line) and yield of milk (broken line) of individual cows, morning or afternoon respectively, over a period of about a fortnight during August 1926. The days of one graph and another do not necessarily correspond, so that the daily variations are not comparable. The graphs indicate that individual rates vary to a much greater extent than yield, and that the variation is apparently independent of yield. Note the steady falling off in the rate of Milker C in both cases studied.]

FIG. 9

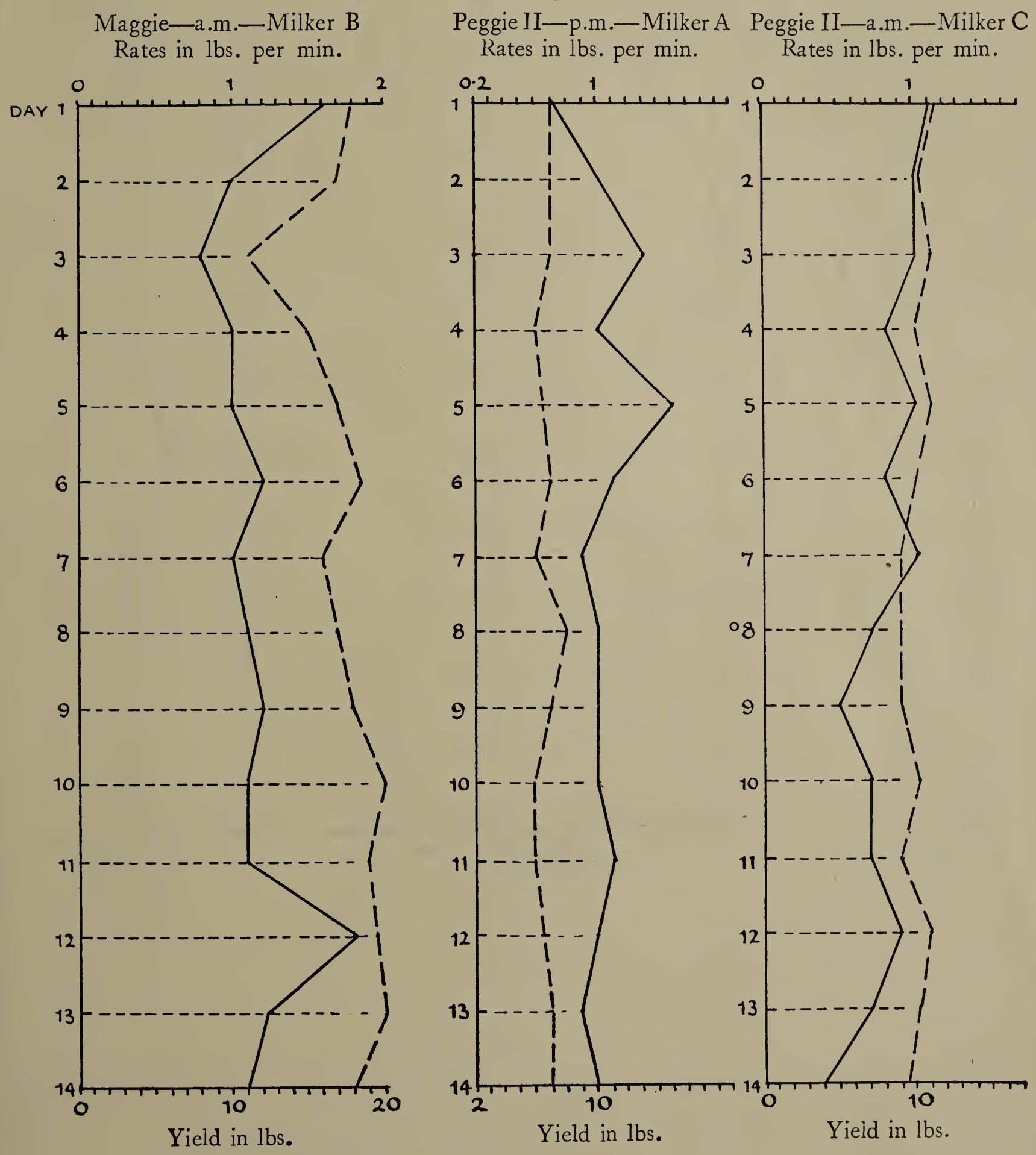
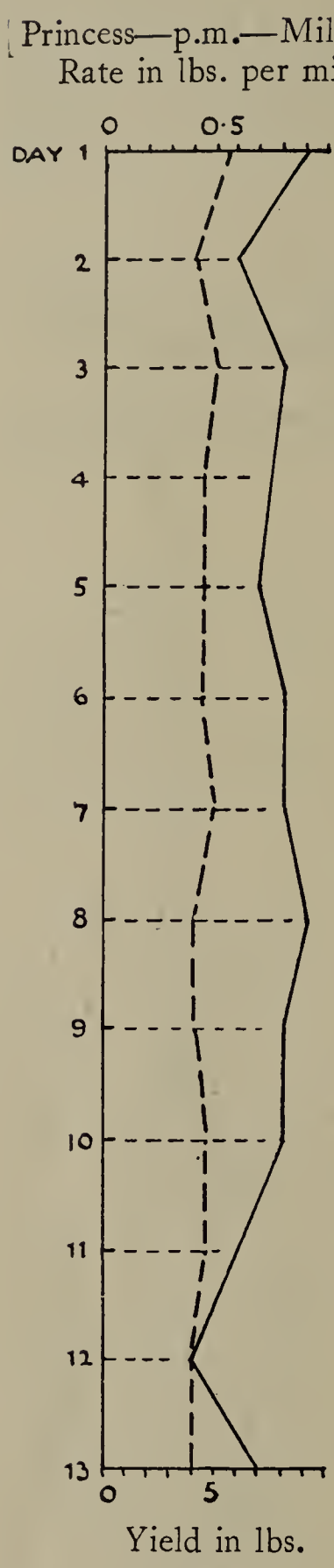
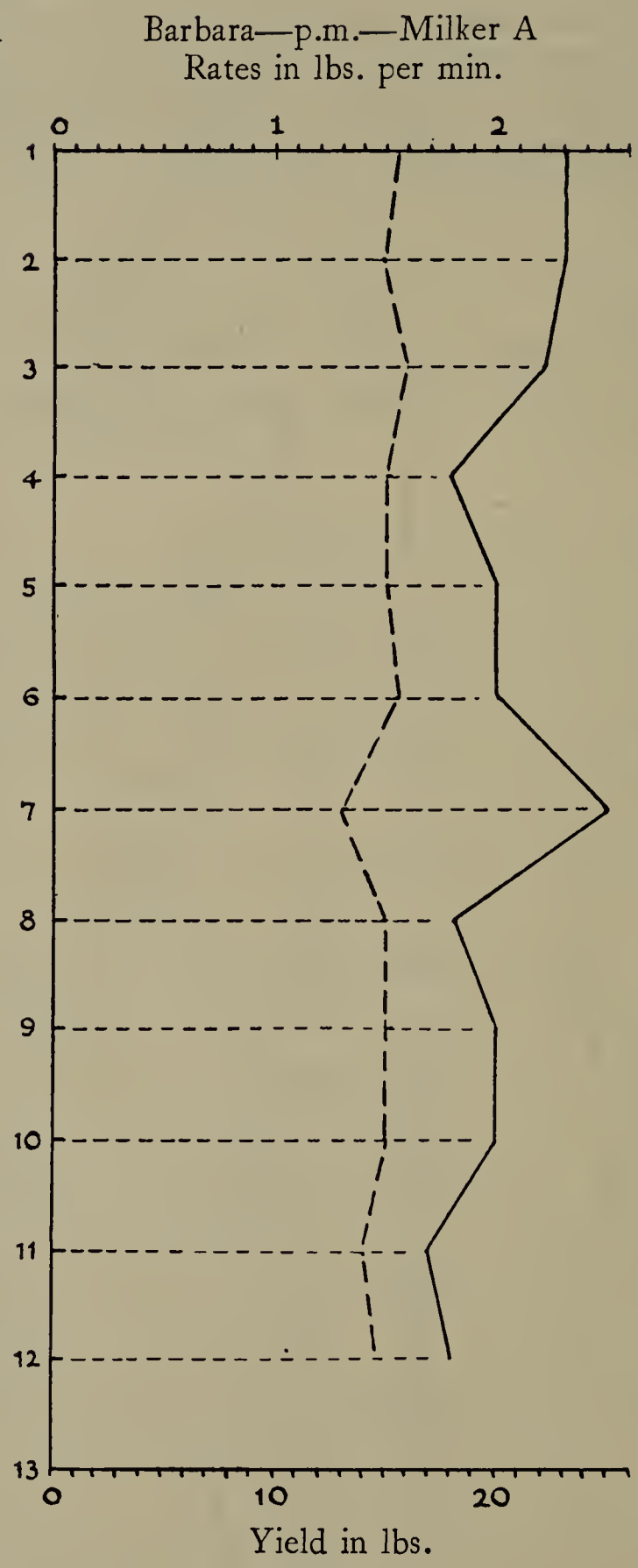


FIG. 10


Princess—p.m.—Milker A
Rate in lbs. per min.
0
0·5
DAY 1
2
3
4
5
6
7
8
9
10
11
12
13
0
5
Yield in lbs.


Barbara—p.m.—Milker A
Rates in lbs. per min.
0
1
2
1
2
3
4
5
6
7
8
9
10
11
12
13
0
10
20
Yield in lbs.

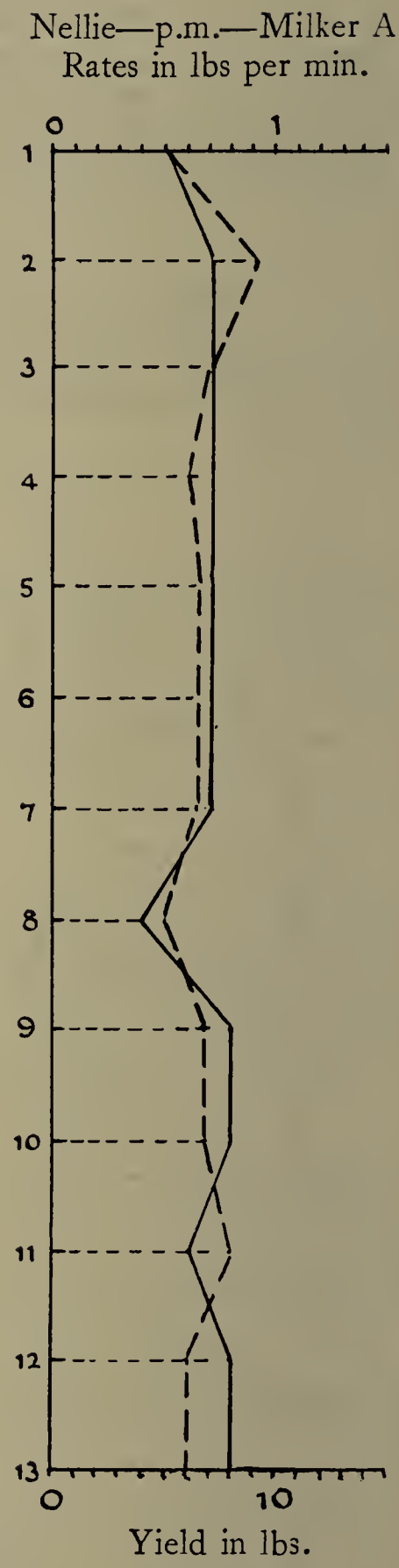

Nellie—p.m.—Milker A
Rates in lbs per min.
0
1
1
2
3
4
5
6
7
8
9
10
11
12
13
0
10
Yield in lbs.

FIG. 11

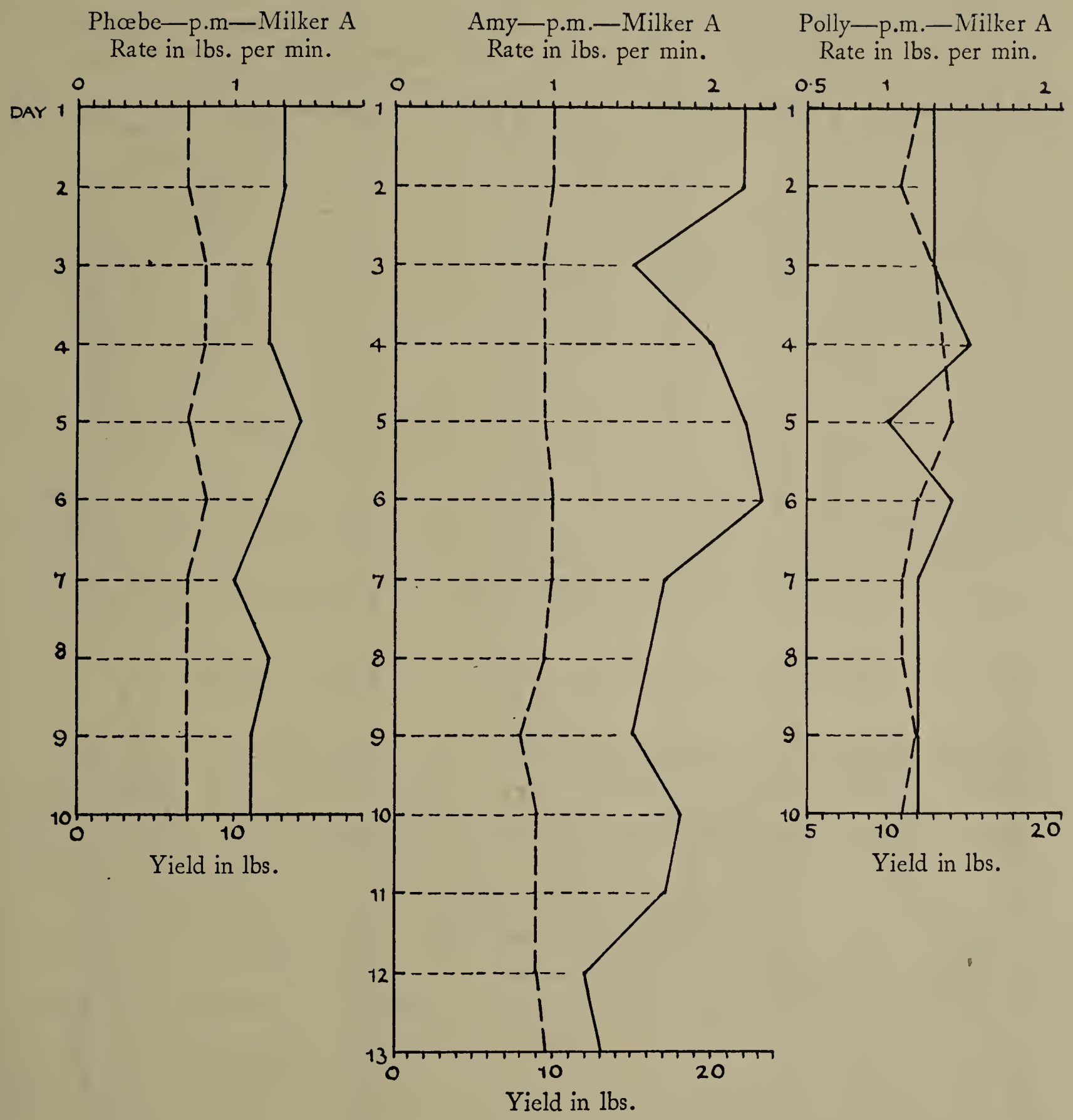
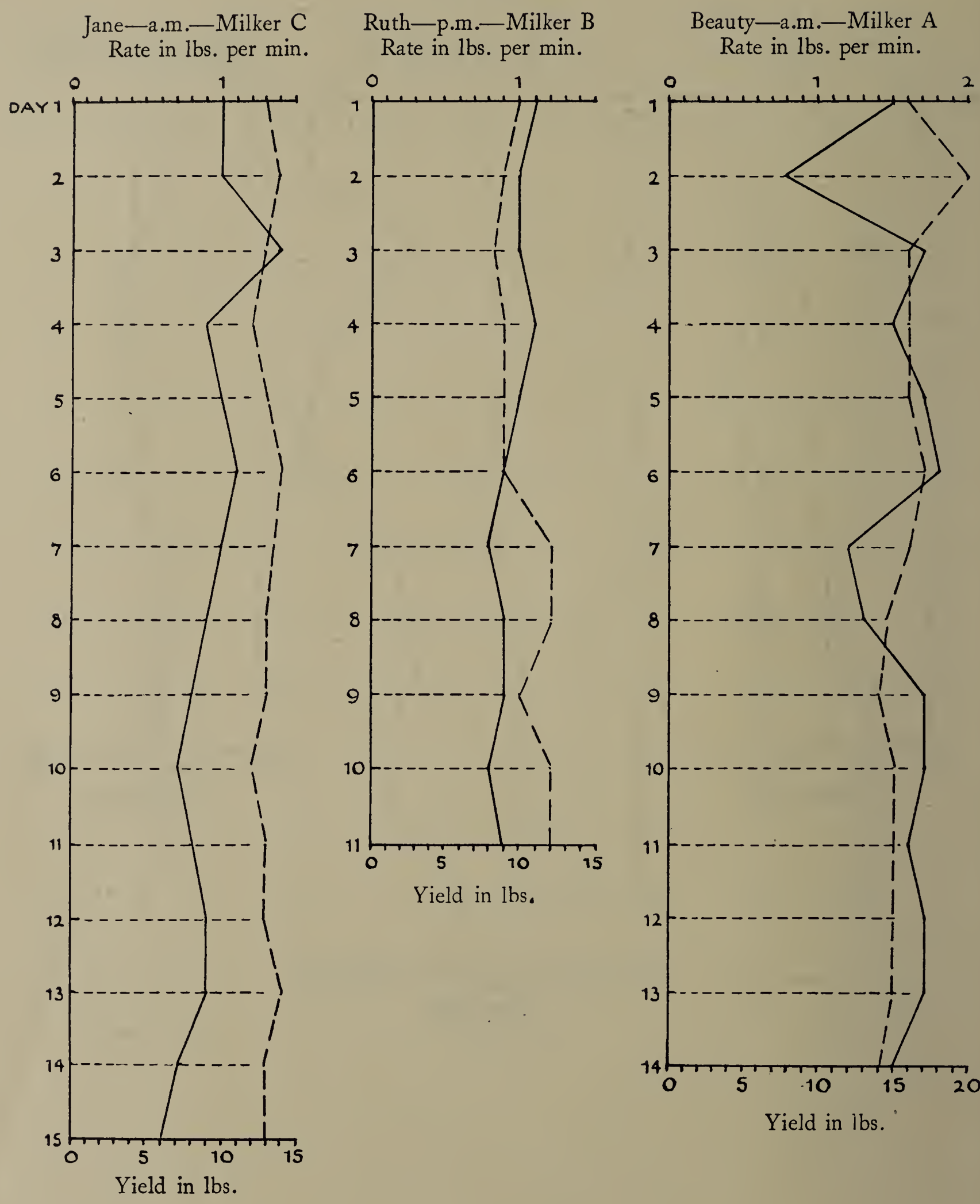

Phœbe—p.m—Milker A
Rate in lbs. per min.
0
1
DAY 1
2
3
4
5
6
7
8
9
10
0
10
Yield in lbs.
Amy—p.m.—Milker A
Rate in lbs. per min.
0
1
2
1
2
3
4
5
6
7
8
9
10
11
12
13
0
10
20
Yield in lbs.
Polly—p.m.—Milker A
Rate in lbs. per min.
0·5
1
2
1
2
3
4
5
6
7
8
9
10
5
10
20
Yield in lbs.

FIG. 12


Jane—a.m.—Milker C
Rate in lbs. per min.
Ruth—p.m.—Milker B
Rate in lbs. per min.
Beauty—a.m.—Milker A
Rate in lbs. per min.
DAY 1
Yield in lbs.
Yield in lbs.
Yield in lbs.

below the mean rate were found to be associated with high temperature or with humidity or with both. But in general no satisfactory connection has been found, and this may be partly due to the fact that the meterological data do not refer to conditions *inside* the cowshed. Conditions of humidity and of air currents need to be determined internally by means of the kata-thermometer. There is little doubt that more detailed investigation would demonstrate the existence of a definite connection.

Among the psychological causes of the individual variations must be included the effects of Saturday and Sunday work. The milkers A, B and C were observed to be in an unfavourable frame of mind on Saturday afternoon and Sunday. They desired to " get through " as soon as possible, and there was a certain feeling of hardship because they were compelled to work when most other people were at liberty to enjoy themselves. (It proved impossible to get the milkers to render any assistance in the experiments on Sundays ; the investigator had to do everything for himself.) This attitude would no doubt have a bad influence on the rate of milking. Other unfavourable daily variations would no doubt be caused by essentially personal conditions, especially those of a temperamental nature. The point of practical importance is that the mean rates of milking could be considerably increased if something could be done to reduce the influence of these disturbing factors.

[F] INCREASING THE RATE OF MILKING

1 *General*

The process of milking has been discussed in considerable detail—in greater detail, it may be thought, than the subject warrants from a practical point of view. It is, however, impossible to make suggestions unless the whole process and situation are fairly closely analysed. From the present inquiry it would seem that the rate of milking could be increased—

(*a*) By the elimination from the herd of constitutionally " hard " cows, of " holders " and of " kickers " which are not exceptionally heavy milkers.
(*b*) By the selection of milkers based upon the qualities needed, both (i) temperamental and (ii) physiological.
(*c*) By the training of milkers.
(*d*) By taking every practicable measure (i) to reduce the number of flies, (ii) to improve ventilation, lighting, etc., (iii) to prevent kicking by the cows.

In addition, some special points requiring attention were noted.

2 *Seating*

The ordinary three-legged milking-stool is in some respects unsatisfactory. Its principal defect is that its height is not adjustable. The distance of the

teats from the ground varies greatly in different cows even of the same breed. The variation may be as much as six inches between cows of the same breed, and as much as one foot between cows of different breeds (*e.g.* Jersey and Shorthorn). Moreover, the height of different milkers varies. The forearms should extend towards the teats parallel to the ground. This is impossible under most circumstances. The disability could be greatly removed by the use of an adjustable stool similar in principle to the piano-stool. The alteration in height could be effected either by means of a tube and shaft with holes and pins, or as in the piano-stool by means of a high-pitched worm-screw arrangement. It is essential that the stool should be easy to keep clean, strong and reasonably light. Some milkers complain of soreness from continual sitting on a flat hard surface. The present stools are also said to be cold in winter. It should be possible to design the sitting surface after the fashion of the seats on agricultural implements and it might be possible to cover the surface with vulcanite or with some other suitable non-heat-conducting substance that can be washed.

3 *Use of Rubber Gloves*

It is important that the hands of milkers be kept as soft as possible. Rubber gloves should be used as far as possible during rough work. When the cows are brushed down and washed, as in clean-milk production, gloves ought certainly to be worn. In winter there is a tendency for the hands to get " chapped " and this must be disastrous to efficient milking.

4 *" Clean-milk " Pails*

The special pails now used in the clean-milk movement (see Fig. 13, p. 65) are effective in protecting the milk from falling dust and dirt, but they necessitate a special act of attention on the part of the milker and special skill in directing the stream into a relatively narrow and oblique orifice. This must tend to reduce the rate of milking. It also leads in the course of a year to considerable waste of milk through the inaccurate direction of the stream. Two ounces of milk are probably lost every time a cow is thus milked at Wye. Twenty cows milked twice a day, this means a loss of 5 lbs. a day, or a loss of 1,825 lbs. per annum.

5 *Lighting*

At Wye artificial lighting is provided by several bare gas jets attached to the beam over the cow's backs. This system of lighting is defective for two reasons. (*a*) Naked illumination of this kind intensifies shadows. (*b*) The situation of the lights is such as to throw the light on the cow's backs instead of upon the parts which the milkers want to see, *i.e.* the hindquarters and udders. Strong diffused light is desirable, and this should be provided by two or three shaded incandescent burners situated along the central passage. They should be

pendant and their height adjustable. Electric light would in many ways be preferable to gas, but gas tends to warm the shed in winter.

Other points will be considered in the next section.

FIG. 13

A " clean-milk " pail

[G] THE MILKING PROCEDURE AS A WHOLE

1 *Different Systems*

The milking procedure, as a whole, may be considered to begin when the cowman goes out for the cows, and to end when the milk is in the churns ready for despatch. This refers particularly to summer milking.

Broadly speaking the procedure within the cowshed falls into two classes according as ordinary milking or " clean-milking " is practised. In the former case the time occupied in the actual milking constitutes a larger proportion of the total time spent on the whole procedure, but it does not follow that there is less unproductive time spent in ordinary milking.

We shall consider only clean-milking[1] in the following pages of this Report.

2 *Time Analysis of " Clean-milking "*

Table 12 shows the high degree of variation in the amount of incidental labour. The high percentage of B's actual milking time is due to the cutting out of " washing-down," etc., due to pressure of time in the morning. The low percentage of C's is the result of an excessive amount of time spent on " washing-down " and the time expended in the dairy on bottling the milk (95 minutes).

It will be noted that the time taken to milk a cow is on the average 12 minutes in the morning as against 7 to 8 minutes in the afternoon. This is due partly to the heavier yield in the morning. The actual rate of milking has been shown to be more rapid in the morning (see p. 55).

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[1] An organised movement to encourage the production of milk of low bacterial content is now general in most countries.

The proportion of incidental labour is, therefore, considerable. It is an important economic fact that most farms which practise clean-milking seldom get all the extra cost returned in the wholesale price which they receive ; they do not at any rate make an extra *profit* on the extra expenditure of capital and labour. The practice, however, of producing clean milk is spreading, partly, it would seem, as the result of propaganda and competitions. Genuine " clean milk " usually has a much lower bacterial content than ordinary milk, and clean milk, as a result, will usually " keep " at least a day longer than ordinary milk. This is really one of its great economic advantages. It enables the market for fresh milk to be geographically extended.

TABLE 12

Showing a Time Analysis of the Operation of Milking

	A Wye College Farm. Typical afternoon milking. 2 milkers and 14 cows. Period : 2 to 5.10 p.m. (190 minutes)		B Wye College Farm. Typical morning milking. 3 milkers and 19 cows. Period : 5.35 to 8 a.m. (145 minutes)		C Farm L. Women milkers. Afternoon. 3 milkers, 1 dairy-woman 20 cows. Period : 2 to 4.15 p.m. (135 minutes)	
Process	No. of workers on each process	Total no. of labour minutes expended	No. of workers on each process	Total no. of labour minutes expended	No. of workers on each process	Total no. of labour minutes expended
Fetching cows	1	15	1	18	1	10
Chaining up	1	4	1	5	1	7
Washing hind quarters	2	52	—	—	3	100
Washing udders	2	12	1	15	3	20
Spraying	2	8	—	—	—	—
Washing hands	2	4	—	—	3	5
Actual milking	2	112	3	228	3	140
Carrying in and weighing	2	20	3	28	3	19
Unchaining and driving out	1	4	1	5	3	8
Driving back to meadow	1	10	1	10	1	5
Putting milk ready for despatch	1	10	1	13	1 (dairy-woman)	95
Total number of minutes expended on the whole operation		251		322		409

Thus the time expended in actual milking, expressed as percentage of the total time expended on the whole operations, is for :

A	44·6
B	70·8
C	34·2

3 *Reduction of Incidental Labour*

In the farms visited by the investigator, it seems likely that incidental labour could be reduced in connection with the following points—(*a*) brushing and washing down, (*b*) spraying, (*c*) proximity and division of meadows.

As regards (*a*), each man (or woman) uses buckets of water. Fetching these for each cow takes up a fair proportion of the time spent in brushing and washing down. A hose should be employed. This would also make the work easier.

As to (*b*), the present practice at Wye is to use a metal drum with a pump and hose attachment. One man does the pumping and the other does the spraying. The man who pumps has also to drag the machine from place to place, since the hose is too short to reach more than four cows at a time. The drum might be placed on wheels or the hose lengthened. But the best arrangement would be to have a tank erected above the level of the cows and the spraying material conveyed in metal pipes right round the cowshed above the cow's backs. The spraying could then be done by gravity, and by means of a single lever the milker could put the whole system in operation. More important still, he could spray periodically during the afternoon (taking care, of course, to protect any exposed milk). This point is emphasised because it is believed that spraying is one of the most effective ways of dispersing flies. As has been already pointed out, flies are a serious source of annoyance during summer afternoons both to milkers and to cows, and certainly constitute a factor influencing adversely both the rate of milking and the yield of milk, day by day.

Concerning (*c*)—the proximity and division of meadows—unnecessary time is spent through certain meadows being too far distant from the cowsheds. It is realised, of course, that soil and other natural conditions frequently determine the location of a meadow ; but instances are to be observed where suitable land could be laid down nearer to the cowshed where the animals are milked. It sometimes occurs that certain cows are milked three times a day. These have to be got out of the general herd at mid-day and quite a considerable waste of time may occur on such occasions, two men often being necessary before the requisite cows can be driven off from the rest. Such cows might be segregated in a special enclosure, at any rate during the day.

III MATTERS FOR FUTURE INQUIRY

[A] EXTENSION OF PRESENT INQUIRIES

1 *Further Work in connection with Fruit and Milk*

Before dealing with other problems, a few words are necessary in regard to the need for extending the work already carried out. This work was accomplished within the short period of three months and in a very restricted geographical area. The work needs repetition, and elaboration, on a number of other farms in different parts of the country, especially on farms some of which are known to be exceptionally well and some exceptionally poorly managed. Comparison is all-important. In addition, such recommendations as have been made in this report and others which may be made as the result of inquiry on other farms ought to be given a practical trial and the effects scientifically observed, and where possible measured. In no other way can sound practical progress be achieved. In some cases the recommendations may be found to be workable and economic ; while in others this may not be so.

2 *Other Manual Processes*

Besides the picking and packing of fruit and the milking of cows, such operations as side hoeing, " singling," planting cabbages, " pulling " mangels and harvesting wheat need to be subjected to time and motion study with a view to making work easier and more efficient, especially among the less skilled workers. The study of the methods of handling different farm animals would also seem worth while.

[B] FARM LAY-OUT

1 *General Indications*

In the course of the present investigation some attention was given to the efficiency of the lay-out of a number of farms, and the observations indicated that a study of this subject on an extensive scale might lead to interesting and useful results. In studying lay-out, the point of view is fundamentally geographical in the sense that the starting-point is the study and comparison of maps and plans. The most important points are (*a*) boundaries and road facilities, (*b*) lay-out of the buildings and position in relation to the fields, (*c*) lay-out of the fields and position of gates, etc., (*d*) position of the workers' cottages, etc. Defects in lay-out are, of course, very often unalterable, but certain minor improvements are sometimes possible. In any case the recognition of the " ideal " is a helpful stimulus in regard to future policies of development.

2 *A Few Illustrations*

The ideal boundary takes the form of a " square " or " block," and it is almost unnecessary to mention that the boundaries of the farms visited, like most other English farms, instead of being quadrilateral, have, on the contrary, every

imaginable irregularity of outline. This necessitates extra hedging and fencing. As regards road facilities, the farms visited varied enormously, and although this is not easily alterable, the exact recognition of differences is important from an economic standpoint. Concerning lay-out of buildings in relation to traffic, on one farm it was observed that carts, in order to reach a certain barn, had to pass through no fewer than four gates within the homestead ; in other cases the barn entrances were too low to allow of " through " traffic, or there was an impediment such as a sinkage of the ground or a raised sill. These are alterable. On another farm, food for cattle had to be carried uphill and across a public road from one set of buildings to another. This, as well as the fact that most farm buildings are non-centrally situated in regard to the fields, could not, of course, be immediately altered. Concerning the lay-out of fields, it appears likely that something could be done on certain farms in regard to the alteration of gates and fences. A case was observed where the existence on one farm of a parcel of land belonging to another caused each trip of the waggon during harvesting to take 13 minutes 30 seconds instead of 9 minutes 15 seconds. The position of the workers' cottages in relation to the farm is a matter of great importance and needs careful investigation. In conclusion, although the study of farm lay-out may not appear to be of much value to the individual farm, its study is very important from the standpoint of British agriculture as a whole.

[C] RELATIONS BETWEEN FARMERS AND WORKERS

1 *Farmers' Attitude of Mind*

It is well known that there is a great difference in the mental attitudes of farmers towards labour and general questions of managerial policy. Some farmers " handle " their men better than others. The methods or " attitudes " of different farmers would seem to be deserving of study—not because there appears to be the same urgent need for it as there is in manufacturing industry and mining—but rather because such an inquiry might prove of assistance to some farmers who are not quite as successful as others. Attitude of mind must not be looked at purely from an economic point of view. A farmer may be financially successful and yet still possess an unsatisfactory attitude of mind. But on the whole, and other things being equal, the farmer who has a progressive, tolerant and genuinely sympathetic outlook will be in the long run more successful financially than those whose attitude is different. A highly important matter for investigation is the planning of farm work.

2 *Workers' Attitude of Mind*

Several interesting attitudes were incidentally discovered among some of the workers on the farms visited during the present investigation. Their attitudes towards their employers, towards their work and towards life in general were in

some cases unfortunate. This applies particularly to their attitudes towards their positions in life and towards their fellow workers (on the same farm). There seems to be a considerable feeling of apathy and inevitability, which is known to be common amongst the rank and file of labour. It is likely that industrial psychological research and education could do something to arouse more enthusiasm and ambition amongst farm workers, thereby stimulating them to greater effort accompanied by higher reward both to themselves and to their employers.

3 *Labour Turnover and Methods of Payment*

The important results obtained by the study of these questions in industry make it extremely probable that a parallel study in agriculture would be valuable.

[D] AGRICULTURAL CO-OPERATION

In comparison with most other countries, Great Britain has not been successful in matters of agricultural co-operation, in spite of the fact that the great importance of such co-operation is widely recognised. It is generally admitted that the fundamental reasons are psychological and it seems important to find out whether the instinctive co-operation trait is constitutionally absent or whether the non-co-operativeness is due mainly to tradition and other factors. So far agricultural co-operation has been studied in this country mainly from a purely economic or at most from a purely social point of view. Investigation from the psychological standpoint might prove illuminating.

[E] VOCATIONAL SELECTION AND GUIDANCE

1 *Selection*

In recording the investigational work in connection with fruit-packing and milking, incidental references were made to the importance of getting the right worker in the right job. In such activities as poultry farming, dairying and glass-house work, where special qualities in the worker are demanded, the farmer usually has to rely upon advertisement, the personal interview and the recommendation of previous employers (if any) as a basis for selection and employment. In industry and trade, objective tests have been devised and used successfully, saving both the employer and candidate much unnecessary disappointment. It seems very probable that similar benefit would accrue from the use of selection tests in certain branches of agriculture.

2 *Guidance*

But more fundamentally important is vocational *guidance*. The aim here is to guide young people, especially those leaving school, into occupations for which they are naturally most fitted. The general impression which the

present investigator derived from conversation with elementary school masters in parts of Kent was that the boys who "go in for" agriculture are chiefly those having a lower level of intelligence and little ambition. Agriculture tends to be looked upon as the last resort and "dumping ground" for those who cannot find work in the towns. It is quite possible that some young people who take up urban employment are really more fitted temperamentally and even intellectually for rural work. The first essential is to determine the predominant traits required for different kinds of agricultural work and then to analyse systematically the temperament and intelligence of every child as he or she passes through the rural elementary school. Any tendency to despise agriculture and to leave it for urban work on the first opportunity is greatly to be deplored. It seems to be partly due to a wrong attitude of mind which might be overcome if greater efforts were made to guide on to the farms those most fitted naturally for this kind of life. The lower standard of (nominal) wages, the social and recreational limitations, and the ties as regards hours (especially in connection with the care of live-stock) are very important factors. But if it were possible to guide into agriculture a better and more ambitious type of young person, naturally fitted for and with a capacity to grow fond of farm life and work, there should be a tendency for both the wages and prospects of farming to increase and for the other factors to exert a less disturbing influence than they do at present. It is important to observe that this applies in principle, not only to the manual worker in agriculture but also to management. It is equally if not more important that the right type of youth should take up farming as an employer. This raises the question whether some attention to vocational guidance could not be usefully given in the Agricultural Colleges.

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